Guidelines for the Control of Methicillin-resistant *Staphylococcus aureus* in New Zealand

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Foreword

The following persons have developed these guidelines:

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These guidelines have been developed in response to the changing epidemiology of methicillin-resistant *Staphylococcus aureus* (MRSA) in New Zealand. The process involved reviewing the previous guidelines, local epidemiological data, other published guidelines, and relevant recent research. It was decided at the outset to utilise the experience and knowledge of those involved in the management of MRSA in New Zealand by putting out draft guidelines for consultation. The two consultation periods produced a significant number of helpful comments. Although there was consensus for most of the document, there was clear divergence of opinion in a few areas in the management of MRSA. In these situations the writing group strove to ensure that the recommendations reflect published data and majority opinion within the country.

This document is not a policy to be rigidly followed by all health care facilities for the control of MRSA. It is a set of guidelines that should be used by an individual facility to develop its own MRSA policy. The guidelines have been written to allow flexible approaches reflecting differences in the local practices and epidemiology of MRSA. However, it is strongly recommended that facilities within a region reach local consensus on how to manage MRSA. This is particularly important for the transfer of colonised patients between health care facilities.

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These guidelines will be periodically updated. Changes will be made to the web-based version of this document.

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The authors wish to thank all those who took the time to comment on the draft versions during the two consultation phases. Most of the suggestions led to changes, and the guidelines have been improved substantially by the consultation process.

Contents

1 Introduction

1.1 General background

Staphylococcus aureus is a potentially pathogenic bacterium which is a natural inhabitant of skin and mucous membranes, especially the nose and perineum. About 30% of healthy adults are colonised with *S. aureus*. Colonisation rates can be higher in certain groups, including diabetics, injecting drug users, people undergoing haemodialysis, people with dermatological conditions, and patients with prolonged hospital stays. Simple colonisation with *S. aureus* has no adverse impact on a healthy person but may result in dissemination of the organism to other people and to the environment. The organism survives well on skin and inanimate surfaces – characteristics that facilitate transmission.

In certain situations *S. aureus* may become invasive and cause disease. This usually occurs in people predisposed through illness or injury. Those already colonised are at greater risk of becoming infected. *S. aureus* can cause a wide range of infections, including skin abscesses, post-operative wound infections, septicaemia and pneumonia. *S. aureus* produces toxins that may cause such diverse manifestations as septic shock, gastroenteritis, toxic shock syndrome, and scalded skin syndrome. The incidence of both community-acquired and hospital-acquired staphylococcal infections has increased during the past 20 years.

Soon after the introduction of penicillin in the mid-1940s, strains of *S. aureus* producing penicillinase were isolated. Penicillinase, which is sometimes called ß-lactamase, is an enzyme that inactivates penicillin. By 1948 the majority of *S. aureus* were penicillin-resistant (Barber and Rozwadowska-Dowzenkom 1948). Methicillin, the first of the semi-synthetic penicillins stable to penicillinase, was introduced in 1960 to combat penicillin-resistant *S. aureus*. Within a year methicillin-resistant *S. aureus* (MRSA) had been detected (Jevons 1961; Knox 1961; Dowling 1961). The predominant mechanism of methicillin resistance is the production of a penicillin-binding protein, which has a low affinity for ß-lactam antibiotics. ß-lactam antibiotics cannot inhibit cell wall synthesis in strains with these altered proteins. MRSA is consequently resistant to all ß-lactams; that is, penicillins, cephalosporins and carbapenems.

Although MRSA was responsible for a significant proportion of *S. aureus* infections in Europe and Asia in the 1960s, there was a general decline in their incidence internationally in the early 1970s (Casewell 1986; Brumfitt and Hamilton-Miller 1989). In the late 1970s MRSA re-emerged, causing larger and more widespread outbreaks. In contrast to strains isolated in the 1960s, these new strains were typically resistant to several antibiotics in addition to ß-lactams, severely limiting treatment options for them (Brumfitt and Hamilton-Miller 1989). By the mid-1980s, multiresistant MRSA had become widespread in several parts of the world, including Europe, the United States and Australia.

Other than resistance to antibiotics, there is no convincing evidence to suggest that MRSA strains as a whole behave differently from methicillin-susceptible strains (Bell 1982). Methicillin-susceptible *S. aureus* (MSSA) and MRSA appear to have equivalent potential for causing colonisation and infection. Reservoirs and modes of transmission are similar for both. MRSA appears to have adherence and survival characteristics similar to MSSA (Duckworth and Jordens 1990). Nor is there any convincing evidence that MRSA are more virulent than methicillin-susceptible strains *per se*. However, because the hospital patients at greatest risk of acquiring MRSA are generally among the more debilitated of patients, and because of the need to use antibiotics that may be less effective and more toxic than ß-lactams, the outcome for patients infected with MRSA may often be worse. While several studies have found that MRSA bacteraemia is associated with an increased risk of death, in most of the studies the MRSA-infected patients had additional risk factors that placed them at greater risk of poorer outcomes (Harbath et al 1998; Whitby et al 2001).

Some strains of *S. aureus* are more likely to spread and cause epidemics. This also appears to be the case for some strains of MRSA, such as the epidemic MRSA (EMRSA) strains described in the United Kingdom. Several of these EMRSA strains (for example, EMRSA-15) have shown a remarkable ability to spread rapidly (Duckworth et al 1998.) Not all MRSA strains demonstrate this same propensity for spread. Similarly, some strains of MRSA may be more virulent than others. For example, it has been suggested that two of the British epidemic strains, EMRSA-15 and EMRSA-16, may be more virulent as they constitute 96% of MRSA isolated from nosocomial bacteraemia cases in the United Kingdom, but only constitute about 60% of all MRSA isolations (Johnson et al 2001).

Initially, MRSA was considered primarily a nosocomial pathogen and strains were typically isolated from patients in larger tertiary and acute-care hospitals. In many countries, however, MRSA is now isolated in most types of health care facility, including those giving long-term care in rest homes and hospitals. During the last five years MRSA have also emerged as a community-acquired pathogen in some parts of the world (Cookson 2000). Unlike most nosocomial strains of MRSA, community-acquired MRSA usually remains susceptible to non-ß lactam antibiotics.

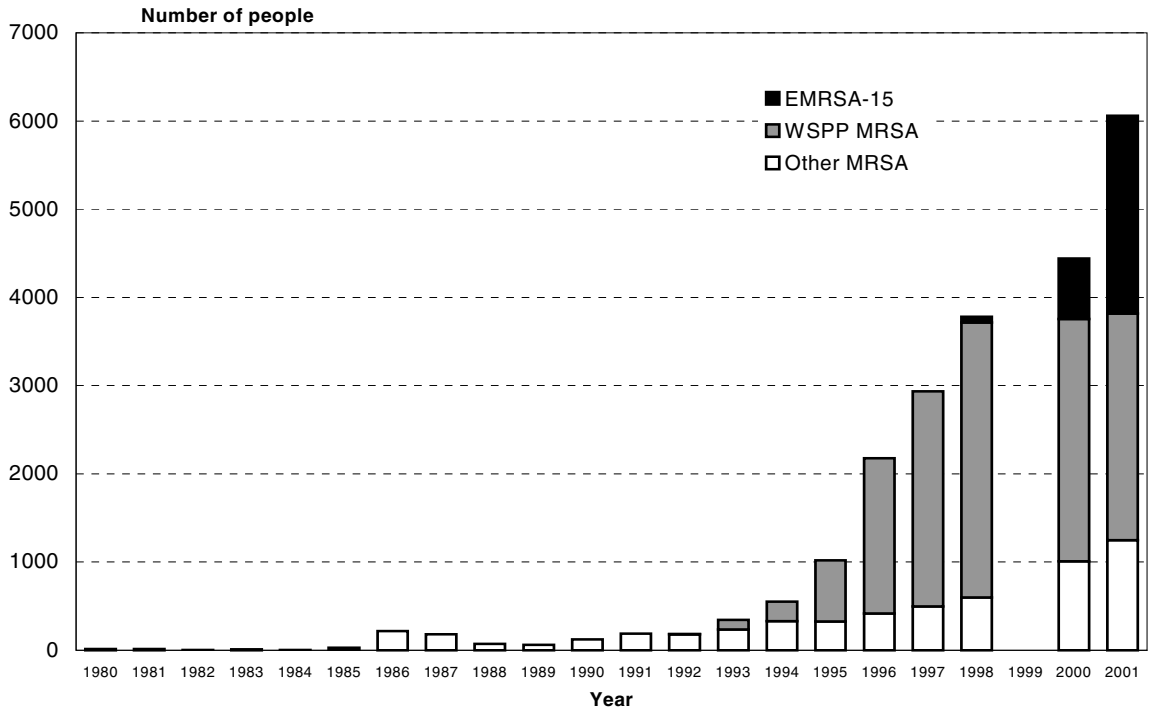
A definition of MRSA

For the purposes of these guidelines, MRSA is defined as *S. aureus* resistant to oxacillin/methicillin. Multiresistant MRSA is defined as *S. aureus* resistant to oxacillin/methicillin and at least two of the following antibiotics: chloramphenicol, co-trimoxazole, erythromycin, fluoroquinolone, fusidic acid, gentamicin, mupirocin, rifampicin, tetracycline or vancomycin. Note that, according to this definition, erythromycin-susceptible isolates of EMRSA-15 would not be categorised as multiresistant, since they are only resistant to β-lactams and ciprofloxacin. However, given the transmissibility of this strain, it is recommended similar control measures be applied when this strain is isolated, irrespective of whether it is multiresistant or not.

1.2 MRSA in New Zealand

MRSA was first isolated in New Zealand in 1975 (Humble 1976). With the exception of outbreaks in two hospitals in the mid- to late 1980s (Martin et al 1989), MRSA remained uncommon until the early 1990s (Heffernan et al 1993). Since that time MRSA isolations have steadily increased (Heffernan et al 1995; Heffernan et al 1997), as is shown in Figure 1. In 2000, based on data collected from hospital and community laboratories, an estimated 6.9% of *S. aureus* were resistant to methicillin (ESR Antibiotic resistance 2001).

Figure 1: MRSA isolations 1980–2001

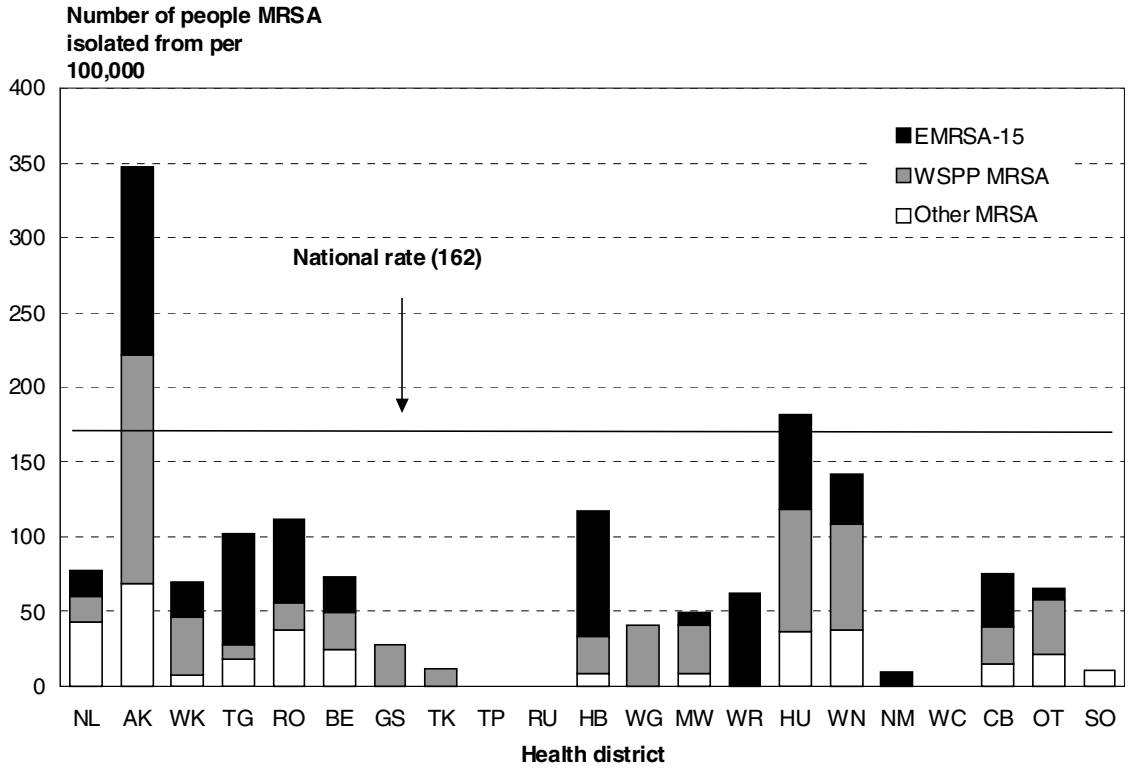


Note: No data are available for 1999. Continuous national surveillance of all MRSA isolations was discontinued in 1998. Data for 2000 and 2001 is based on one-month surveys conducted in those years. No survey was undertaken in 1999.

Most of the increase in MRSA in New Zealand during the 1990s was due to the spread of two strains, denoted WSPP (Western Samoan phage pattern) 1 and WSPP 2. By the late 1990s WSPP MRSA accounted for three-quarters of all MRSA isolated in New Zealand (see Figure 1) (Heffernan et al 1997). These MRSA strains are not usually multiresistant and commonly are only resistant to ß-lactam antibiotics. They are usually community-acquired and not associated with nosocomial outbreaks of MRSA infection. WSPP MRSA was first isolated – and continue to be disproportionately isolated – from Pacific peoples. Consequently, WSPP MRSA is most common in areas of the country with the large populations of Pacific peoples, such as Auckland (see Figure 2). Outbreaks of non-multiresistant, community-acquired MRSA, associated with people in lower socioeconomic groups, are now being reported in other countries, including Canada, the United States, and Australia (Groom et al 2001).

In the 1990s the epidemiology of MRSA in New Zealand, with the predominance of WSPP MRSA, was distinct from most other countries. Over two-thirds of MRSA was isolated from community patients and less than 20% was multiresistant. However, this epidemiological pattern has started to change with the arrival and spread of one of the highly transmissible British epidemic MRSA strains, EMRSA-15. This strain is multiresistant – although not exceptionally so – and usually hospital acquired. In addition to resistance to ß-lactams, it is resistant to ciprofloxacin and erythromycin, although the erythromycin resistance can be variable. About 10% of EMRSA-15 being isolated in New Zealand is erythromycin susceptible. By 2001 EMRSA-15 accounted for 40% of MRSA isolated in New Zealand, and also accounted for most of the increase in MRSA between 2000 and 2001. Concomitantly, the proportion of WSPP MRSA diminished to 39% (Figure 1) (ESR Antibiotic resistance 2002).

Figure 2: Annualised incidence of MRSA, by health district, 2001



Note: Health districts: NL = Northland; AK = Auckland; WK = Waikato; TG = Tauranga; RO = Rotorua; BE = Eastern Bay of Plenty; GS = Gisborne; TK = Taranaki; TP = Taupo; RU = Ruapehu; HB = Hawke's Bay; WG = Wanganui; MW = Manawatu; WR = Wairarapa; HU = Hutt; WN = Wellington; NM = Nelson-Marlborough; WC = West Coast; CB = Canterbury; OT = Otago; S0 = Southland.

As a consequence of the spread of EMRSA-15, which is predominantly a hospital pathogen affecting elderly patients, MRSA is becoming common, and is endemic in some New Zealand hospitals and long-term care facilities. There is considerable variation in the incidence of this strain throughout New Zealand, with Auckland having the highest rate (Figure 2). There have also been large outbreaks of EMRSA-15 in hospitals in other areas, most notably Wellington and Hawke's Bay.

1.3 Reduced susceptibility of *S. aureus* to glycopeptides

Strains of *S. aureus* with reduced susceptibility, or intermediate resistance, to glycopeptides have been reported from a number of countries (Tenover et al 2001). Isolates showing homogeneous intermediate resistance to vancomycin, with minimum inhibitory concentrations (MICs) ≥ 8 mg/L, are rare. There are, however, increasing reports of isolates showing heteroresistance, often with vancomycin MICs in the range of 1–4 mg/L (Hiramatsu et al 1997; Howe et al 1998; Ariza et al 1999; Kantzanou et al 1999; Giesel et al 1999; Wong et al 2000; Trakulsomboon et al 2001; Marchese et al 2000; Ward et al 2001). The former are termed vancomycin-intermediate *S. aureus* (VISA) or glycopeptide-intermediate *S. aureus* (GISA), and the latter heteroresistant VISA (hVISA). Almost all isolates with reduced susceptibility to glycopeptides have arisen in pre-existing MRSA infections during vancomycin treatment. Despite relatively low rates of MRSA infection in New Zealand, MRSA isolates from two patients clinically failing vancomycin treatment have been shown phenotypically to be hVISA (S Roberts, personal communication, January 2002).

The laboratory detection of these isolates is difficult (Tenover et al 2001; Walsh et al 2001). If reduced susceptibility to glycopeptides is suspected, either because of an apparent treatment failure or from the results of initial routine susceptibility tests, further testing needs to be performed using methods that have been shown to be sensitive and specific for the detection of VISA and hVISA (see section 10.6). Many VISA and hVISA isolates initially appear mixed, demonstrating two colony types. Any isolate with suspected reduced susceptibility to vancomycin should be sent to the Institute of Environmental Science and Research (ESR) for confirmation.

Since MRSA is known to be highly transmissible in health care settings, it is reasonable to expect VISA and hVISA strains to be equally transmissible, although cross-infection between patients has not yet been reported. The Infection Control Team should be immediately notified of the isolation of any suspected VISA. As these isolates appear to arise from pre-existing MRSA, the patient should already be in isolation. The management of patients found to be colonised or infected with VISA or hVISA strains is the same as for those colonised or infected with MRSA. Compliance with infection control precautions should be strictly enforced and monitored (Centers for Disease Control 1997).

1.4 Guidelines for controlling the spread of MRSA

While there is sometimes debate about the net benefit of efforts to control MRSA, especially in health care facilities where the organism is already endemic (Barrett et al 1998), the majority of expert opinion is that specific programmes to control MRSA do reduce MRSA infections and are cost-effective (Duckworth and Heathcock 1995).

The control of MRSA, particularly multiresistant MRSA, is important for several reasons:

- the high cost, greater frequency of side effects, and poorer clinical outcome with alternative treatments (for example, vancomycin)
- the limited number of oral agents that can be used
- the potential for the emergence of resistance to vancomycin, which would seriously restrict the choice of agents appropriate for treating serious MRSA infections.

Appropriate antibiotic use is essential in the control of emergence and spread of resistant organisms

The control of MRSA should be put into perspective. There are other multiresistant micro-organisms in health care settings capable of causing serious and difficult-to-treat infections. While MRSA has received a lot of attention, any multiresistant organism should be of concern to a health and disability care institution, and appropriate control efforts should be initiated when these pathogens are encountered. There is some evidence that MRSA control efforts may positively affect the rate of other hospital-acquired infections (Cosseron-Zerbib et al 1998).

Antibiotic use – and especially misuse – is irrefutably linked to the development of resistance. Therefore, the prudent use of antibiotics is an essential part of any programme to limit the development and spread of resistant organisms. The New Zealand Infection Control Standard states that all health and disability care institutions should have policies to promote the appropriate use of antibiotics; that is, prescribing guidelines that maximise therapeutic impact while minimising toxicity and the development of resistance (Standards New Zealand 2000). Major health and disability care institutions should have antimicrobial resistance surveillance programmes, and information on the prevalence of resistance should be made available to prescribers. Additional strategies to address antibiotic resistance and hospital-acquired infections are identified in *An Integrated Approach to Infectious Disease: Priorities for Action 2002–2006* (Ministry of Health 2001).

The original guidelines for the control of MRSA in New Zealand were published in 1992 (Department of Health 1992). Significant changes in the prevalence and epidemiology of MRSA in New Zealand have occurred since then, prompting these revised guidelines. Many factors need to be considered in developing practical recommendations for the control of MRSA, including:

- patterns of transmission
- prevalence of MRSA in the population or facility
- transmissibility of particular MRSA strains
- susceptibility of the population
- available resources.

Due to the variability in these factors, it is difficult – if not impossible – to develop recommendations that will be entirely appropriate and acceptable to all health care facilities. For example, in facilities with endemic MRSA, which admit patients from a community or other facilities with a high prevalence of MRSA, attempts to eliminate MRSA may be futile and efforts should focus on containment (Rubinovitch and Pittet 2001). In other facilities, eliminating sporadic cases and outbreaks is both desirable and feasible. These revised guidelines, therefore, are not a policy to be explicitly followed by health care facilities, but rather a guide that should be used by an individual facility in developing its own MRSA policy. They also provide a basis for the common understanding of the control of MRSA, which can be used to facilitate interactions between health care facilities, and, in particular, the transfer of patients between facilities. All health care facilities' infection control policies, including MRSA policies, should comply with the New Zealand Infection Control Standard (Standards New Zealand 2000).

These guidelines have been formulated primarily for the control of MRSA strains that are transmissible in health and disability care institutions, particularly multiresistant strains such as EMRSA-15. In most situations, standard precautions are adequate for the control of community-acquired, non-multiresistant MRSA not associated with nosocomial infection (for example, WSPP MRSA). It is expected that there will be some variation between health and disability care institutions in the application of the control measures recommended in the guidelines to community MRSA strains.

2 Modes of Transmission and Risk Factors for MRSA

Before outlining procedures for the control of MRSA, it is important to understand the modes of transmission and risk factors for acquiring MRSA.

2.1 Modes of transmission

MRSA is transmitted primarily by person-to-person spread, most often on the hands of health care personnel which have been transiently contaminated by contact with infected or colonised patients (Duckworth et al 1998; Jarvis 1988). Although hospital personnel who are persistently colonised or infected with MRSA have been reported, such carrier-disseminators appear to be uncommon and their role in the transmission of MRSA to patients is difficult to determine (Lessing et al 1996). However, there have been outbreaks of the EMRSA-15 strain in New Zealand hospitals where the apparent source has been a health care worker formerly employed in a British hospital (H Heffernan, personal communication, January 2002).

Transmission may occur from droplet-shedding by persons with lower respiratory tract secretions containing MRSA during coughing, and procedures likely to provoke droplet formation. Dispersion of skin squames during patient-care activities, such as bed-making, has been proposed as another mechanism for MRSA transmission. This is particularly relevant for patients with exfoliative skin conditions. The significance of either mode of transmission has been difficult to demonstrate (McNeil and Solomon 1985).

There is evidence that the environment may act as a reservoir of MRSA and contribute to an ongoing problem with MRSA acquisition in the hospital (Rampling et al 2001). A high standard of hygiene within the hospital environment should be maintained to minimise contamination of floors, bedding, curtains, etc. If an outbreak of MRSA continues an environmental reservoir should be considered. Outbreak investigation may identify the probable mode of transmission and help direct intervention measures.

2.2 Risk factors

A number of risk factors have been reported to increase the hospitalised patient's susceptibility to MRSA. These factors include type of clinical service, the patient's age, associated co-morbidities, and the kinds of therapeutic interventions (Lessing et al 1996). Carriage rates are higher in certain patient groups, including those:

- with insulin-dependent diabetes
- undergoing haemodialysis, or continuous ambulatory peritoneal dialysis
- who are injecting drug users
- with *S. aureus* skin lesions
- with HIV (Kluytmans et al 1997).

In general, inadequate ward or unit staff, or staff training, overcrowding of patients, lack of isolation facilities, frequent relocation of patients and staff, and poor attention to infection control procedures increase the risk of MRSA as well as other nosocomial infections (Vicca 1999).

3 Screening for MRSA

In this section 'screening' means swabbing people to detect MRSA carriage. In determining who should be screened, information needs to be obtained on where the person has been and their past MRSA status. Many facilities use a structured screening questionnaire to identify those who require swabbing, and this approach is recommended.

Screening is one component in the control of MRSA in a health care facility. Identification of infected or colonised patients and staff members allows for the appropriate management of these persons to prevent spread to others. Screening of new staff members and patients may prevent the introduction of MRSA to a facility. Screening during the investigation of an outbreak will determine the extent of spread. The screening process, however, can become very costly in staff time and laboratory materials, and therefore must be undertaken in a rational and organised manner. It should be noted that no method of MRSA screening is 100% sensitive.

In the past, routine screening has focused on patients and staff who have been overseas, especially in overseas health care facilities. In many parts of the world (for example, Australia, the United Kingdom, the Pacific Islands, parts of Europe, South Africa and the United States) MRSA is more common than in New Zealand. Patients and staff from overseas hospitals may be infected or colonised, and are known to have introduced MRSA into New Zealand hospitals.

Based on the current prevalence of MRSA in New Zealand, the most common means of MRSA spread between health care facilities in this country is now the admission of a patient who has been in another New Zealand health care facility rather than one overseas. In 2001, just 1.5% of people from whom MRSA was isolated were reported to have a history of travel overseas (ESR, in press). Therefore, it is now just as important to consider screening patients from New Zealand health care facilities with current MRSA transmission as it is to screen patients who have been in overseas health care facilities.

3.1 When is screening appropriate?

Full information should be provided to both the patient and his or her whānau/family, and to staff. This will include information on the implications of MRSA colonisation, infection and treatment, and the need for prevention measures such as hand hygiene and isolation. This will help to increase understanding, and to allay concerns (see Appendices 3 and 4).

Screening of selected patients and staff for MRSA is appropriate in the following situations:

- admission or transfer of patients from facilities known or suspected to have MRSA (see section 3.1.1)
- pre-employment screening of staff (see section 3.1.2)
- outbreak screening (see section 7).

3.1.1 Admission or transfer of patients between facilities

Isolation on admission

Patients meeting the following criterion should be isolated on admission and screened for MRSA.

- The patient has previously been found to be colonised and/or infected with MRSA. Three consecutive sets of negative swabs are required before being taken out of isolation. The timing of the taking of the swabs is to be determined by the receiving facility.

Consider for isolation on admission

Patients meeting the following criteria should be screened for MRSA and considered for isolation on admission.

- The patient has been hospitalised or has worked in a ward or unit in a health care facility in New Zealand where, in the last six months in that ward or unit, MRSA has been recovered from two or more staff members or patients *not* maintained in Contact Precautions since admission. One set of negative swabs is required before being taken out of isolation.
- The patient was hospitalised or worked in a health care facility overseas in the last six months. One set of negative swabs is required before being taken out of isolation.

Where possible, the patient should be admitted to an isolation unit or a single room with ensuite facilities. Contact precautions must be maintained until the patient is cleared. Patients may be screened during pre-admission clinics or at the transferring facility; however, it is usually the responsibility of the receiving facility to swab the patient on transfer (see section 6: Transfer of Patients with MRSA).

The Infection Control Team should determine when isolation is discontinued.

If swabs are positive, the patient should receive care as directed in section 4: Management of Patients with MRSA.

3.1.2 Staff: pre-employment or return to duty after employment elsewhere

Before commencing duty, all staff who are to have patient contact (whether newly appointed staff or staff returning from temporary duty at another health care facility) and those who meet any of the criteria below, should be screened for MRSA as close as possible to the date of their starting duty if they have had direct patient contact. Consideration should also be given to screening agency, locum and visiting clinical staff.

Local circumstances must be taken into account, particularly when staff work across institutions on a regular basis. In these circumstances institutions commonly sharing staff should adopt a common policy in order to avoid unnecessary repeated screening.

Criteria for screening staff

- The staff member worked at, or was a patient in, a health care facility overseas within the last six months. One set of negative swabs is required before clearance for general duties.
- The staff member worked in a ward or unit at, or was a patient in, a New Zealand health care facility where, in the last six months in that ward or unit, MRSA has been recovered from two or more staff members or patients *not* maintained in Contact Precautions since admission. One set of negative swabs is required before clearance for general duties.
- The staff member has previously been found to be colonised or infected with MRSA. Three consecutive sets of negative swabs are required before clearance. The Infection Control Team is to decide which patient duties, if any, can be undertaken during treatment and clearance (see Figure 3, section 5).

Ideally, the facility should endeavour to ensure the screening results are known before the staff member commences work. This policy requires co-ordination with the human resources department. When swabs are positive, follow-up must be undertaken as directed in section 5: Management of Staff with MRSA.

Responsibility for collecting swabs, payment for swabs (employee or employer) and employee activities while awaiting screening results are the decision of the individual health care facility.

The need and frequency for follow-up and/or screening for MRSA carriage in previously infected staff members should be determined by the Infection Control Team at the facility (see section 5.2).

3.1.3 Investigation of a suspected outbreak

The investigation and control of a suspected outbreak of MRSA can be complex, and we postpone discussion of this to section 7: Outbreak Investigation and Control.

3.2 Methods for collecting specimens

3.2.1 Staff

Opinions vary on the need to obtain a perineum/groin swab from staff. Recent unpublished data from two New Zealand hospitals suggests that nasal swabbing reliably detects MRSA carriage in staff and that perineum/groin swabs do not increase the sensitivity of screening (Hutt Hospital and Wellington Hospital, personal communication, March 2002). Nasal swabs also detected all staff carriers on initial screening in a United Kingdom study (Cox and Conquest 1997). However experience differs in another New Zealand hospital where perineum/groin swabs were the only site positive in 17% of staff being screened (M Schousboe, personal communication, April 2002).

Recommended specimens

The following specimens should be collected on all staff being screened:

- one nasal swab (used to swab both anterior nares)
- swabs of any wounds or skin lesions.

The need for perineum/groin swabs from staff is a decision each facility should make for itself.

3.2.2 Patients

Yields from screening swabs

The yield of MRSA from screening swabs is directly related to the number of sites sampled and the methods of detection used. The sensitivity of sampling different sites varies between studies. In a study of 403 MRSA patient carriers (Coello et al 1994), the sensitivity of various sampling sites for detecting carriage was:

- nose alone 79%
- nose and throat 86%
- nose and perineum 93%
- nose, throat and perineum 98%.

In another study of long-term MRSA carriers (Sanford et al 1994), the performance of swabbing different sites was:

- nose alone 93%, negative predictive value 95%
- groin or perineum 39%, negative predictive value 69%
- axilla 25%, negative predictive value 64%
- nose and infected wounds 100%, negative predictive value 100%.

Recommended specimens

The following specimens should be collected on all patients being screened:

- one nasal swab (used to swab both anterior nares)
- one swab from the perineum/groin (the perineum is preferred because of the higher yield from this site)
- swabs from possible sites of infection such as skin lesions (including paronychia), pressure sores, venous access sites, surgical wounds, tracheostomies and lower respiratory tract secretions; the umbilicus should be swabbed in neonates
- urine is the most appropriate specimen to collect for patients with an indwelling urinary catheter.

Note: swabbing these sites should result in two to three swabs for most patients.

3.2.3 General screening recommendations

The swabs should be moistened in the sterile swab transport medium, sterile water or saline. Swabs should be rubbed over the indicated area several times and submitted to the laboratory without delay, clearly labelled 'MRSA specimen' so that the appropriate culture techniques are applied.

The role of throat carriage in the spread of MRSA remains uncertain. The use of throat swabs in routine screening is not recommended. If clearance of the carrier state proves difficult, throat swabbing should be considered.

Rescreening is recommended if a known previously positive patient/staff member has recently received antibiotic therapy. The timing of this needs to be decided by the facility.

Screening of patients or staff during antibiotic therapy may provide false negative results. The decision to swab during antibiotic therapy should be taken in consultation with a clinical microbiologist or an infectious diseases physician. If swabbing is undertaken during antibiotic treatment, reswabbing will be required after treatment has been completed.

4 Management of Patients with MRSA

This section deals with patients other than those in residential care facilities, general practices or in the community.

In normal circumstances the clinical microbiologist, infection control nurse or laboratory charge technologist should notify the ward immediately of the isolation of MRSA. Once a case is recognised, a logical sequence of events should be put into action so that the patient can be managed appropriately, further spread inhibited, and the possibility of an outbreak investigated. The Infection Control Team will be instrumental in directing these activities (see section 7: Outbreak Investigation and Control).

Full information should be provided to both the patient and his or her whānau/ family. This will include information on the implications of MRSA colonisation, infection and treatment, and the need for prevention measures such as hand hygiene and isolation. This will help to increase understanding, and to allay concerns.

Māori patients and whānau should be provided with information that is given in a culturally appropriate manner. On-site Māori support services based in many hospitals can help with this.

Other ethnic groups, including Pacific peoples, will have similar needs for culturally appropriate information and support.

4.1 Hand hygiene

The importance of hand hygiene

Transient carriage on the hands of health care personnel is the major mode of transmission of MRSA. Greater emphasis should be given to improving hand hygiene practices among health care personnel. Hand hygiene is one of the most important measures in preventing the spread of MRSA in hospitals (Guilhermetti et al 2001).

Most handwashing protocols, which call for 15 to 20 seconds of handwashing, bear little resemblance to what actually occurs in health care settings. The time, demand and inconvenience of repeated handwashing, poor access to handwashing facilities (such as lack of sinks, or sinks that are physically blocked by equipment) and the desire to prevent dermatitis, which can develop after frequent handwashing, contribute to the low compliance with handwashing protocols.

Consideration should be given to the use of alcohol-based hand rubs for routine hand hygiene. Studies have shown alcohol rubs to be effective in the removal of MRSA from both lightly and heavily contaminated hands Guilhermetti et al 2001). One recent study

suggests alcohol-based hand rinses have superior antibacterial efficacy to alcohol-based hand gels (Kramer et al 2002).

Alcohol-based hand rubs/gels take less time than washing and are more effective in reducing microbial loads. Washing is necessary, however, to remove visible soiling. Alcohol-based rubs/gels can also provide improved compliance (there is no dependence on sinks and plumbing) and improved tolerance (they can be less irritating to hands than soap and water). For optimal adherence to hand hygiene recommendations, easy access to hand hygiene supplies is essential.

For both efficacy and compliance reasons, alcohol-based hand rubs/gels are the preferred method for hand hygiene in 'clean' clinical situations where MRSA is an issue. Nevertheless, hands must be washed using soap and water and dried thoroughly:

- before commencing work
- after contact with blood, body fluids, secretions and excretions
- when hands are visibly soiled
- after the removal of gloves
- before refreshment breaks
- after six applications of alcohol-based hand rubs/gels
- at the end of a duty (Boyce and Pittet 2001).

4.2 Patient isolation

Following the isolation of MRSA, an infected or colonised patient should be transferred to a properly equipped isolation unit or a single room, ideally with ensuite facilities, where contact precautions can be maintained. The implications of MRSA colonisation, infection, and treatment, including isolation, should be explained to both the patient and his/her family/whānau. This should include written information relating to the specific facility. (For examples of the type of information that could be made available, see appendices 3 and 4.) The patient should remain in contact isolation until considered clear of MRSA by the Infection Control Team.

Where optimal patient care is unlikely to be jeopardised, the single room should be located away from high-risk areas. There should be a clearly visible notice outside the room advising those wishing to enter the room to contact a nominated staff member.

When a health care facility has several patients with MRSA, it may be desirable to cohort patients in a single large room or small ward, rather than to distribute the cases throughout a ward or hospital. If there are limited facilities for isolation, priority should be given to those patients who constitute the greatest risk of cross-infection (for example, those with infected wounds, exfoliative skin conditions, chronic respiratory disease and extensive skin or wound colonisation).

4.3 Category of isolation

Note: Standard precautions shall be employed at all times for all patient contact. Contact precautions are additional precautions for known or suspected MRSA patients. Droplet precautions may occasionally be required (see section 4.3.2 and Appendix 6).

4.3.1 Contact precautions

In addition to standard precautions, contact precautions are used for specified patients known or suspected to be infected or colonised with epidemiologically important micro-organisms that can be transmitted by:

- direct contact with the patient – hand or skin-to-skin contact that occurs when performing patient-care activities that require touching the patient's dry skin
- indirect contact with environmental surfaces or patient-care items in the patient's environment.

Contact precautions particularly important for MRSA include the following.

Patient placement

Place the patient in a single room where possible. When a single room is not available, consult with the Infection Control Team regarding placement.

Gloves

Single-use disposable gloves are to be worn when entering the room if there is a likelihood of touching contaminated items. Gloves are to be changed between tasks and procedures on the same patient, and after contact with material that may contain a high concentration of micro-organisms. Gloves should be removed promptly after use. Gloves are not required when entering the isolation room just to talk to the patient. Hand hygiene should be carried out by all persons leaving the room.

Hand hygiene

Routine hand hygiene procedures using alcohol-based hand rubs/gels are recommended, with handwashing being carried out as stated for standard precautions.

Gown/apron

A gown/apron should be worn when entering the room if it is anticipated that the health care worker's clothing will have contact with the patient, environmental surfaces, or items in the patient's room. A long-sleeved gown is preferred when patient contact, such as lifting, occurs. Remove the gown/apron before leaving the patient's environment. After removal of gown/apron, staff should ensure that their clothing does not contact potentially contaminated environmental surfaces to avoid transfer of micro-organisms to other patients or environments.

4.3.2 Droplet precautions

In addition to standard precautions and contact precautions, the following aspect of droplet precautions should be used for patients known to be infected or colonised with MRSA in the lower respiratory tract when large-particle droplets (over 5 μm in size) are to be generated during coughing, sneezing, or the performance of procedures.

Droplet precautions involve standard and contact precautions with the addition of surgical masking:

- when working within a metre of a patient with MRSA present in lower respiratory secretions when large particle droplets are being or are likely to be produced.

4.3.3 Other requirements for masking

Masking is not routinely indicated when caring for an MRSA patient. Skin squames with MRSA can, however, become suspended in air during bed-making. How often this leads to staff colonisation is unknown.

Masking is indicated:

- when bed-making for patients with exfoliative skin conditions. The use of masks for bed-making for other MRSA patients is seldom required. Nevertheless it may be appropriate in some circumstances. For example, a recent study demonstrated suspension of MRSA in the room air of patients when bed-making was performed. These patients all had MRSA in their respiratory tract secretions and had recently undergone head and neck surgery (Shiomori et al 2001).

4.4 Labelling case notes

An alert system should be established to enable the screening of previously positive patients or patients who are readmitted having had exposure to MRSA. The Infection Control Team should be notified before, or on, readmission of the patient. Examples of an alert system are computerised alert identification or admission cards.

4.5 Staffing of the isolation room

Contact precautions and hand hygiene procedures should be reviewed routinely with staff caring for MRSA patients. Staff with exposed skin lesions should not provide care for MRSA patients. The number of staff members in contact with the patient should be restricted, and movement of these staff to other areas of the hospital should be minimised and recorded.

4.6 Patient movement

When patient movement is necessary, either for investigation or treatment, arrangements should be made with the department involved so that contact precautions can be implemented. To minimise time spent in a department, patients should be sent for when the department is ready, thereby minimising exposure risk to other patients.

Appropriate isolation and decontamination procedures should be maintained by all persons in direct contact with the patient (for example, the radiologist, physiotherapist and transport staff). This includes wearing long-sleeved disposable gowns or disposable plastic aprons, gloves and masks (where appropriate), and the use of alcohol-based hand rubs/gels or handwashing. If the patient has unhealed skin wounds or lesions, these should be covered with an impermeable dressing. During transport, the wheelchair, trolley or stretcher should be covered with a clean sheet. This sheet should be discarded into a soiled linen container at the completion of transportation.

4.7 Surgery

MRSA clearance treatment should be considered before elective surgery. Ideally, clearance should be initiated at least 24 hours before surgery. When surgery is necessary and antibiotic prophylaxis is required, vancomycin should be considered. A clinical microbiologist and/or infectious disease physician should be consulted in deciding on prophylaxis and treatment.

There is no need to place MRSA-positive patients last on a theatre list. Standard theatre precautions (such as wiping tables between patients) are sufficient.

Transport and theatre staff should be made aware of the patient's MRSA status. Appropriate infection control practice and decontamination procedures should be maintained by all persons in direct contact with the patient (for example, anaesthetist, transport staff).

4.8 Visitors

Visitors should be allowed to enter the patient's room only after receiving appropriate information on MRSA and the local MRSA policy. They should be requested to limit their visit to the MRSA patient only, or, alternatively, visit the MRSA patient last if visiting other patients. Visitors are not required to wear any protective clothing, but should wash their hands or use an alcohol hand rub before leaving the patient's room.

4.9 Treatment of colonised patients

Colonisation, *per se*, does not always require eradication or the administration of systemic antibiotic therapy.

Eradication of carriage of MRSA is not always successful. The organism may persist for weeks or months after discharge from hospital. Throat carriage, colonisation of extensive skin lesions, surgical wounds and intestinal colonisation are particularly difficult to clear. Skin lesions and surgical wounds may continue to yield organisms until completely healed.

Regimens for treating colonised patients include the use of topical and systemic antimicrobial agents, and antimicrobial body washes. Although there is little evidence of the relative efficacy of the use of antimicrobial body washes in eradicating *S. aureus* (Boyce 2001; Watanakunakorn et al 1995), this is widely recommended, and seems logical in an attempt to reduce the bacterial burden. There is scientific evidence to support the effectiveness of the use of topical intra-nasal agents with or without systemic antibiotics (Parras et al 1995; Fernandez et al 1995; Harbath et al 1999; Watanakunakorn et al 1992; Hill et al 1988; Doebbling et al 1993). Treatment of colonised patients will be influenced by the susceptibility profile of the patient's isolate (see sections 4.9.1 and 4.9.2).

Situations for which eradication should be considered include:

- surgery
- invasive procedures
- admission to high-risk areas
- lengthy hospitalisation (for example, two weeks or more).

Consultation with a clinical microbiologist and/or infectious disease physician should be sought in the treatment of MRSA-colonised or infected patients. Prolonged use of topical antibiotics, including mupirocin, is strongly discouraged to prevent the emergence of resistant organisms. Systemic treatment of infections due to other organisms must be reviewed and discontinued unless absolutely necessary, since use of other antibiotics promotes colonisation by MRSA.

Since the introduction of mupirocin to New Zealand, resistance to mupirocin among *S. aureus* has emerged. Mupirocin-resistant MRSA is described as low-level mupirocin-resistant MIC equal to 8 mg/L to 256 mg/L or high-level resistant MIC ≥ 512 mg/L. Nationally in 2001, 6.3% of MRSA isolates were resistant to mupirocin, 70% of which was high-level resistance (ESR, in press). Clearance of mupirocin-resistant MRSA with mupirocin has been shown to be less likely than susceptible strains: 86% clearance of susceptible strains versus 44% clearance of resistant strains when the nares only were colonised, and 56% versus 33% when other sites were colonised as well. Treatment in this study used mupirocin four times daily for two weeks (Semret and Miller 2001).

4.9.1 Regimen for clearing mupirocin-susceptible MRSA

Use of a combined regimen for five days should be considered for those with uncomplicated carriage of MRSA.

The following regimen has been successful in the treatment of nasal carriage or carriage in small lesions of mupirocin-susceptible MRSA strains or low-level (MIC ≤ 256 mg/L) mupirocin-resistant MRSA strains:

- application of mupirocin (Bactroban®) to the anterior nares twice a day – infected skin lesions with MRSA should be treated as for those with MSSA; appropriate systemic antibiotics may be necessary

- use antiseptic washes for daily washing of the skin and bathing – appropriate agents include chlorhexidine 4%, triclosan 1%, and povidine iodine 7.5% in detergent solution
- wash the hair twice weekly with the antiseptic wash.

4.9.2 Regimen for clearing mupirocin-resistant MRSA

Use of a combined regimen for five days should be considered for those with uncomplicated carriage of MRSA. The following regimen has been successful in the treatment of nasal carriage, or carriage in small lesions of high level (≥ 512 mg/L) mupirocin-resistant MRSA strains.

- If susceptible, apply fusidic acid (2% sodium fusidate salt in paraffin ointment) twice daily intranasally and oral sulphamethoxazole/trimethoprim (adult dose 480 mg twice daily)

  or

  application of povidine iodine (10%) ointment twice daily intranasally.
- Use antiseptic washes for daily washing of the skin and bathing. Appropriate agents include chlorhexidine 4%, triclosan 1% and povidine iodine 7.5% in detergent solution.
- Wash the hair twice weekly with the antiseptic wash.

4.10 Tests for clearance

Clearance should be determined by the Infection Control Team. Ideally, swabs should be taken from the nose, perineum, and all other sites previously known to yield MRSA. If antimicrobial therapy has been given, collection of swabs should be delayed for at least 48 hours after completing treatment. Three consecutive negative sets of swabs (each separated by at least 24 hours) are usually required before the patient is considered 'clear'. When determined to be clear, the patient may be transferred from the isolation room or unit to a low-risk ward. As relapses may occur, consideration should be given to screening at weekly intervals. This is particularly recommended if the patient remains in a high-risk unit or ward.

Eradication of MRSA from surgical wounds, device-insertion sites and extensive skin lesions is frequently difficult. These sites may continue to yield the organism until healing is complete, so it is prudent to regard these patients as a possible source of infection until all wounds have healed, regardless of clearance results. The local application of antiseptic agents may reduce the numbers of MRSA to a level difficult to detect by routine laboratory procedures, so that swabs taken during treatment may give false negative results.

4.11 Environmental cleaning

No special cleaning is required for the daily management of isolation rooms. However, these rooms should be cleaned last (Rampling et al 2001). Routinely clean isolation rooms with an all-purpose detergent and water, ensuring that all horizontal surfaces are damp-dusted, and floors vacuumed. Regular cleaning regimes for the management of air vents, radiators and bed curtains should be developed.

Rooms vacated by MRSA-infected/colonised patients should be cleaned thoroughly according to local cleaning policy before the admission of the next patient to that room.

Curtains around the beds and windows should be changed/laundered. It is not usually necessary to clean walls and ceilings, unless there is visible soiling. Contaminated linen and waste should be dealt with according to normal hospital policy.

4.12 Patient discharge

The general practitioner, district nurse and other community health agencies involved in the patient's care should be informed of the patient's MRSA status prior to discharge from hospital. For an example of the type of letter that should be sent to those caring for the patient see Appendix 1. If the patient does not complete treatment for MRSA, the general practitioner and district nurse should be sent a copy of the treatment schedule and protocol to assess clearance. If the patient is discharged to a nursing or convalescent home, the medical and nursing staff should be informed in advance. For an example of the type of letter that could be sent to the receiving facility see Appendix 2. The patient should be informed that there is no risk to healthy relatives or others outside the hospital.

Household contacts who are hospital workers with direct patient contact are a concern because they may acquire MRSA from the patient. In this situation, the Infection Control Team should be kept informed.

Note: Carriage of MRSA should not be a contraindication to the transfer of a patient to a nursing or convalescent home or hospice.

5 Management of Staff with MRSA

Staff members are usually found to be positive for MRSA by pre-employment screening, or incidentally if they present with an infection, or as part of an outbreak investigation. When a staff member is identified as colonised or infected, the unit manager, occupational health clinic and Infection Control Team should be consulted. The employing organisation should have clear guidelines as to who is responsible for the management of the staff member. The management will need to be individualised, depending on the sites of infection/colonisation, where the staff member is employed, the type of MRSA, and the ability of the staff member to perform other duties.

Community-acquired strains of MRSA that are β-lactam resistant only, such as WSPP1 and WSPP2, are common in some parts of New Zealand and do not appear to cause undue problems with nosocomial transmission and disease. Management of staff colonised with these strains needs to be tailored to the particular health and disability care institution. Unless there is evidence that the WSPP strain and staff member are linked to an outbreak, they should be managed as for MSSA. Hospital-acquired strains of MRSA tend to be resistant to more antibiotics and have been associated with outbreaks of cross-infection.

The following is the suggested approach to the management of staff with MRSA colonisation (see Figure 3 for a summary).

5.1 Initial follow-up and treatment of positive staff

Except for staff members designated to provide care exclusively to MRSA patients, current staff found to be positive for MRSA may be considered for removal from clinical duty. If staff screening is performed in a unit where MRSA is present, it should be performed before the staff member commences a shift to distinguish colonisation from transient acquisition during the shift (Cookson et al 1989). The staff member should be re-swabbed before any treatment is begun to confirm the findings and/or to determine the specific site(s) of infection or colonisation. The sites listed in section 3.2 (nose and any skin lesions) should be swabbed. The staff member should be assessed to determine if there are underlying reasons they may be colonised/infected (for example, a skin condition which may predispose them to re-colonisation following treatment).

Note: Consultation with the clinical microbiologist and/or infectious disease physician should be sought in the treatment of MRSA-colonised or infected staff in hospitals and residential care facilities.

Treatment of colonised staff will be influenced by the susceptibility profile of the staff member's isolate. (See sections 4.9.1 and 4.9.2 for treatment options for MRSA.)

Some facilities manage the clearance procedure of staff, while others ask the person's regular health care provider to treat the patient. If the facility does not manage clearance, it should provide clear written instructions for the staff member and the person treating them to follow.

Regardless of the regimen used, attention should also be given to the staff member's hand hygiene practices, and to predisposing health problems or potential risk factors within the staff member's home environment that may lead to re-colonisation.

5.2 Determination of clearance

The timing of clearance swabs is a balance between being able to have staff return to full duties as soon as possible, while ensuring the best likelihood of detecting failed clearance treatment. Waiting for the result of a previous swab before taking another set of swabs means that a staff member is off work, or on restricted duties, for well over a week. For many institutions this would cause a considerable staffing problem, particularly in an outbreak.

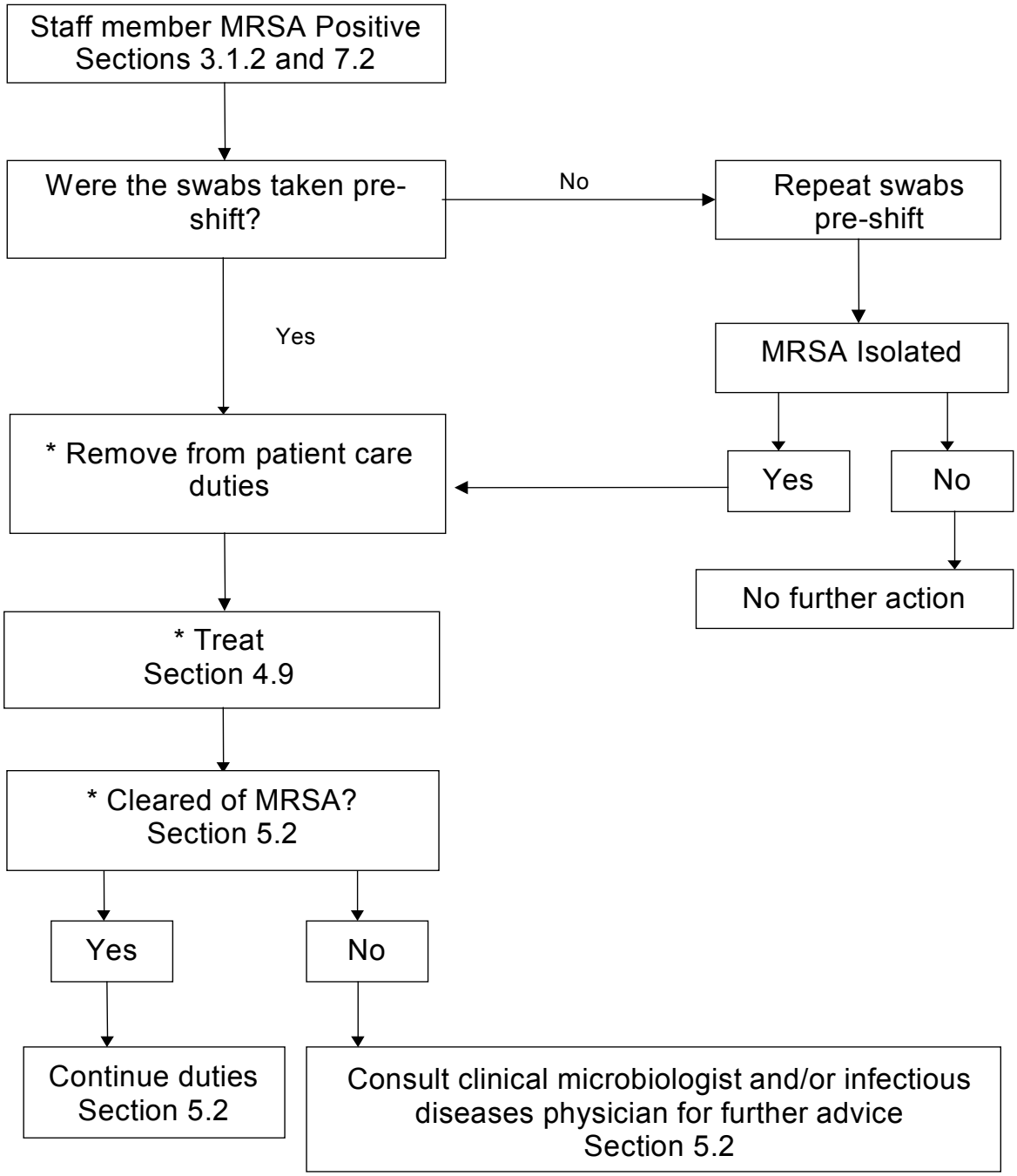
The following recommendations take into account these issues and allow for flexibility depending on the epidemiological situation.

- Three sets of swabs should be collected from the nose and any skin lesions (see section 3.2: Methods for collecting specimens).
- If antimicrobial therapy has been given, collection of swabs should be delayed for at least 48 hours after completing treatment. The swabs should be collected at intervals of at least 24 hours.
- If all three sets of swabs are found to be negative, the staff member can assume clinical duties. It will be up to the individual health care facility to decide which areas within their institution the staff member can work in.
- It is also recommended that follow-up surveillance for MRSA carriage by that staff member be carried out, especially if the staff member has frequent courses of antibiotics or other risk factors for reacquisition of MRSA colonisation.
- The frequency of swabbing and the duration of surveillance are to be determined by the Infection Control Team at the health care facility.

Some investigators have found nasal carriage of MRSA to become undetectable within 24 hours of initiating mupirocin ointment treatment (Bell 1982). Returning to work 24 hours after starting clearance treatment may be appropriate for low-risk settings. It is up to the Infection Control Team in each health care facility to decide which patient duties, if any, can be undertaken during treatment and clearance. The importance of strict adherence to standard and contact precautions needs to be re-emphasised.

Staff members who remain persistently colonised should be referred to a clinical microbiologist and/or infectious disease physician for review and discussion about further management options.

Figure 3: Flow chart for managing staff colonised with MRSA



* The Infection Control Team is to decide which patient duties, if any, can be undertaken during treatment and clearance.

6 Transfer of Patients with MRSA

Although individual hospitals can best determine policy for the control of MRSA in their own institution, agreement on control measures is necessary when transferring patients between hospitals to foster a smooth transition, minimise the stress placed on patients and their families, and prevent the spread of MRSA in other facilities. Considerable attention has been given to the transfer of known MRSA infected/colonised patients, but attention must also be given to the patient who is not known to be infected or colonised with MRSA but who is being transferred from a facility with recent MRSA transmission.

Colonisation or infection should not prevent the transfer of patients. Infection Control Teams from both the transferring and receiving hospital should be involved in making the decision to transfer a patient. The decision to transfer should, however, be influenced by the availability of appropriate facilities at the receiving hospital (for example, single rooms or isolation facilities, the ability of the hospital to provide the necessary care given that the patient will have to be kept in contact isolation, and the potential benefit to the patient).

Staff at the transferring hospital are responsible for alerting the receiving health and disability care institution of any suspected MRSA risk. This can be the Infection Control Team, but more often would be the senior ward nursing staff involved in organising the transfer. The information to be passed on to the receiving facility would include whether the patient was colonised or infected with MRSA, whether the patient was coming from a ward or unit with recent transmission of MRSA, and the result of all swabs, including the susceptibility profile of the MRSA strain. (See Appendix 2 for an example of the type of letter that should be sent to the receiving facility.)

If the patient is not known to be infected or colonised with MRSA, however, it is the receiving hospital's responsibility to screen for MRSA, unless negotiated otherwise. If the receiving hospital does not have the appropriate facilities to isolate the patient, or if clearance of the patient may allow initiation of appropriate patient care more rapidly, arrangements may be made with the transferring hospital to swab and clear the patient before transfer. In general, however, screening is the responsibility of the receiving hospital.

Note: Open and clear communication between infection control and ward personnel at the transferring and receiving institutions is essential for the smooth transfer of patients and the maintenance of good relationships between facilities.

When a decision is made to transfer the patient, all persons involved should be made aware of the MRSA status of the patient before the transfer. This includes not only the clinician who will be responsible for the patient and the Infection Control Team at the receiving hospital, but also the ambulance or other transport service personnel.

Contact precautions should be maintained by all persons in direct contact with the patient. During transport, the wheelchair, trolley or stretcher should be covered with a clean sheet. Infected lesions should be covered with an appropriate occlusive dressing. After use, gowns/aprons and the sheet should be discarded into a soiled linen container for appropriate laundering.

7 Outbreak Investigation and Control

The investigation of a suspected outbreak of MRSA can be complex and requires carefully planned epidemiological, microbiological and (occasionally) environmental studies. Screening for MRSA may be a useful adjunct to the investigation, but it must be undertaken as part of a co-ordinated plan and should only be done under the direction of the Infection Control Team. Part of the co-ordinated plan will include education, information and support for staff, and a verbal and/or written summary at the conclusion of the investigation detailing the findings.

Management of an outbreak is often a stressful time for patients and staff. While the control of MRSA is important, the patient's medical and psychological welfare should not be compromised. Staff, including the Infection Control Team, have an important role to play in providing information and reassurance to patients.

The approach below follows many of the recommendations of the recent British guidelines (Duckworth et al 1998).

7.1 Outbreak investigation

7.1.1 Epidemiological studies

To best understand the dynamics of an outbreak, epidemiological studies should be undertaken to discover persons infected and colonised with MRSA. These may identify specific characteristics of persons with MRSA which help to identify exposures that may be associated with MRSA transmission. As a first step, detailed epidemiological information should be collected on all colonised and infected patients (cases). This could include:

- basic demographic information (such as age, sex, ethnicity)
- patient's location (and previous locations) in the facility
- date of admission, and chart of which days were spent in which location
- which caregivers have had direct contact with the patient
- presence of skin lesions, surgical wounds or invasive devices, and history of invasive or other special procedures
- diagnosis, especially conditions with a negative impact on patients' immunocompetence
- antibiotic treatments
- previous hospitalisations overseas or at other New Zealand health care facilities.

Using this information, cases can be characterised with respect to person, place and time. Occurrences common to cases or linkages between cases may help to delineate the pattern of spread of MRSA and help to formulate a preliminary or working hypothesis.

If cross-infection with MRSA continues despite review and reinforcement of standard and contact precautions, a case-control study may provide an indication on the source and mode of spread. Information on potential risk factors or exposures to MRSA should be collected for both cases and controls in a standardised manner and the findings compared using appropriate statistical tests. Exposures or characteristics significantly more common among cases than controls are likely to be associated with the source of the MRSA or the mode of transmission. Advice from an epidemiologist and statistician should be sought early in the design of any case control study.

7.1.2 Microbiological studies: strain determination

Determining the MRSA strain involved in an outbreak is an important part of the investigation. Identifying different strains among cases in an outbreak provides strong evidence that the cases are not related, whereas the identification of a common strain suggests that cases may be related (for example, through cross-infection or a common source of infection). The presence of a common strain, however, must be interpreted carefully because some strains are relatively common in New Zealand and could be introduced from multiple sources. Phage typing is currently the principal method of distinguishing strains in New Zealand. When required, other typing methods are available to provide additional discrimination between isolates. Once cross-infection is suspected, the laboratory should be requested to retain relevant isolates for typing.

MRSA strain identification may also provide insight into the dynamics of an outbreak. Using information from previous outbreaks, strains characterised as having increased transmissibility or epidemic potential, or which have been associated with environmental spread, can be recognised, providing useful information on the mode of transmission.

7.1.3 Environmental studies

Although MRSA has been isolated from various environmental surfaces during an outbreak, the environment is not a reservoir in most MRSA outbreaks. An exception is MRSA in a burns unit or head and neck surgery unit, where heavy contamination of the environment can occur (Shiomori et al 2001; Rutala et al 1983). The presence of MRSA on inanimate surfaces or objects appears to be a consequence of patient colonisation and infection rather than a cause of it. As a result, environmental studies are rarely required.

However, some consideration should be given to the environment if an outbreak is not contained through control of the more usual sources of infection (patients and staff). Environmental sampling should be done only under the supervision of the Infection Control Team and as part of an agreed, co-ordinated plan.

7.2 Outbreak control

7.2.1 Course of action when infected or colonised patients are detected

The course of action taken when a patient colonised or infected with MRSA is detected depends on a variety of factors including:

- the type of ward

  - non-acute
  - acute
  - intensive care or other high-risk unit
- the facilities available for patient isolation
- the experience of MRSA in the hospital
  - first identification of MRSA in the hospital or unit
  - frequent re-admissions and transfers but little spread
  - evidence of spread
  - MRSA endemic locally
- ward design
- whether affected patients are likely to be heavy shedders of MRSA (for example, those with burns or infected eczema)
- the viruluence and transmissibility of the strain. Often this will not be immediately apparent but may be known if the patient was MRSA-positive previously and the strain was typed.

Categories of risk and the appropriate control procedures are outlined below, but these may overlap. It is not possible to give recommendations covering all circumstances, and decisions need to be based on the local situation. Local assessment together with these guidelines should indicate the appropriate course of action for the Infection Control Team. The hospital's infection control policy should identify which clinical areas are included in each clinical risk category (see below).

Note: The overriding principle is to ensure that optimum patient care is maintained.

7.2.2 Action in an acute hospital without endemic MRSA

Every reasonable effort should be made to detect colonised or infected patients on admission and to prevent spread of the organism. Action following the identification of early cases in any area of the hospital should be as described below in 'high-risk areas of a hospital where MRSA is endemic'.

7.2.3 Approach where MRSA is endemic

An endemic situation occurs when there is the continuing presence and transmission of MRSA in a given hospital, or in a specific group of patients in the hospital, despite standard control procedures. Active intervention in an endemic situation can be effective in reducing the overall numbers of colonised and infected patients. The Infection Control Team should continue to assess its occurrence, whether most cases are new acquisitions within the hospital or admissions and transfers of already affected patients.

The general principles of infection control should be reviewed and reinforced, with emphasis on:

- monitoring compliance with infection control policies

- increased cleaning in affected wards, including a schedule for thorough cleaning of all wards in rotation
- reviewing antibiotic policies, particularly antibiotics used for prophylaxis and empiric therapy
- reducing movement of patients between wards.

See below for additional preventive precautions, which may be added to the endemic measures if resources are available: for instance, in low, moderate and high-risk categories. Units containing vulnerable patients, such as transplant units and intensive care units, should be given priority for maximal precautions.

Low-risk areas of a hospital where MRSA is endemic

These include most medical wards: general, acute care of the elderly and non-neonatal paediatric. On identification of a single case:

- basic infection control measures should be re-emphasised
- manage the index case as detailed in section 4: Management of Patients with MRSA
- screening of other patients is not usually necessary, but consider it if clinical infections are detected.

Moderate-risk areas of a hospital where MRSA is endemic

Normally these would include the following wards, but local factors may dictate changes to this:

- general surgical
- urological
- neonatal/well-infant nurseries
- gynaecology/obstetric
- dermatology.

The action should be as detailed above, with the addition of the following measures:

- screen the nose, perineum, skin lesions and manipulated sites of all patients in the room or ward if there are two or more cases with circumstantial evidence of transmission
- screen staff if there is evidence of further spread after a suitable period of intervention
- manage colonised patients and staff as detailed in section 4: Management of Patients with MRSA, and section 5: Management of Staff with MRSA.

High-risk areas of a hospital where MRSA is endemic

These include specialist wards or units where the consequence of uncontrolled MRSA is serious because of the risk of invasive infection and difficulties in treatment, such as:

- intensive care
- special care baby units/neonatal intensive care units
- burns

- transplantation
- cardiothoracic
- orthopaedic
- trauma
- vascular
- regional, national or international referral centres.

The action should be as detailed above, with the addition of the following measures:

- assess the need to screen the nose, perineum, skin lesions and manipulated sites of other patients in the unit after a single case
- screen staff with skin lesions for MRSA who have cared for the patient (screening must be done before a shift)
- screen all staff only if additional cases of MRSA occur.

7.2.4 Patient isolation

Contact precautions should be instituted for affected patients in high- to low-risk clinical areas in a fresh-encounter or an endemic situation. However, the patient's medical and psychological welfare should not be compromised by unnecessarily restrictive infection control practices. The Infection Control Team should be contacted in case of doubt (see section 4.2: Patient isolation).

7.2.5 Ward closure

Ward closure should be considered only after a risk assessment has been carried out by the Infection Control Team, with a full assessment of all available facts by all involved. Factors that should be considered include:

- the virulence and transmissibility of the MRSA strain
- clinical activity and availability of alternative facilities locally
- staffing levels, skill mix, dependence on agency staff
- number of cases
- patient case mix in the ward or unit
- whether risk of transmission outweighs benefit of admission
- continuing transmission of disease despite usual infection control measures.

8 Management of MRSA Patients in the Community

Patients colonised or infected with MRSA may be cared for in many different community settings. These include rest homes, long-term care facilities, general practice, hospices, other residential institutions, as well as those cared for in the home either by district nurses or other community health care providers. All health and disability care organisations must have an infection control programme as outlined in the Infection Control Standard NZS 8142: 2000 (Standards New Zealand 2000). This should include formulation of policies and procedures for the management of MRSA and the usage of antibiotics, education and surveillance. A designated staff member should be appointed to deal with infection control matters.

8.1 Residential care facilities (RCFs)

The following recommendations are suggested for RCFs (Strausbaugh et al 1996).

- Hand hygiene is the single most effective means of preventing the spread of MRSA.
- Residents who are colonised with MRSA should not be denied entry into RCFs. There is no evidence that such a policy will prevent the introduction of resistant organisms into a facility. Entry of resistant bacteria into RCFs does not appear to increase facility infection rates, or necessarily lead to excess morbidity or mortality.
- Decolonisation therapy should not be required for residents colonised with MRSA before their admission to an RCF.
- RCF residents colonised with MRSA should not be restricted from participation in social or therapeutic group activities unless there is reason to think that they are shedding large numbers of bacteria and have been implicated in the development of infection in other residents.

There is no evidence that restriction of colonised residents from dining rooms or rehabilitation group activities is required to prevent spread in these settings. Such restrictions cause deprivation of social contact and rehabilitation opportunities, which may impair convalescence or quality of life of the affected residents. Strict isolation and other restrictions of movement should be reserved for instances where residents may be shedding large numbers of organisms into the environment (for example, large wounds not contained with dressings or tracheostomies with frequent coughing) *and* who are also linked epidemiologically with other residents who acquired infections with the same strain of MRSA. Residents with acute infection rather than colonisation should be isolated appropriately.

- RCFs should be informed if a patient is infected or colonised with MRSA before their transfer.
- Surveillance cultures should not be performed routinely on patients awaiting transfer. Routine surveillance should be appropriate for the facility concerned.

- Routine precautions in all RCFs should include adequate sinks, education, incentives and other resources required to ensure that contact precautions, when required, can be maintained.
- The use of invasive devices such as urinary catheters, feeding tubes and tracheostomies should be minimised. Ongoing education that emphasises measures most likely to prevent cross-colonisation should be made available.
- Control measures for MRSA should reflect the incidence of MRSA in the facility.
- For RCFs without infections caused by MRSA in the preceding year, and few, if any, colonised patients, no additional control measures are advocated.
- For RCFs with a low-level endemic infection rate (for example, < 1 per 1000 resident days), the following additional control measures are recommended:
  - surveillance data should be analysed monthly to identify cross-infection or cross-colonisation
  - residents infected or colonised with MRSA should not be placed in rooms with debilitated, non-ambulatory patients who are at greatest risk of becoming colonised or infected. Single rooms, if available, and cohorting strategies should be used judiciously to minimise dissemination of MRSA from patients shedding large numbers of organisms into the environment, such as residents with colonised wounds not fully covered with dressings, incontinent residents with urinary or faecal carriage, or colonised residents with tracheostomies and difficulty handling respiratory secretions.
- For RCFs with high rates of endemic infection (for example, > 1 per 1000 resident days) or an outbreak (for example, greater than three infections in a week or twice the number of infections in a month than had been observed in the previous three months), consultation with an experienced infection control expert is recommended.

8.2 Outpatient clinics

Carriage of MRSA is asymptomatic and therefore many carriers go undetected. This means that good infection control practices must be employed for all patients – *not* just those known to be colonised or infected with MRSA.

If a patient is known to be positive for MRSA, it is important to notify the clinic before the first visit. This will allow the clinic to consider the following.

- Hand hygiene should be performed before and after dealing with the patient.
- The patient should be dealt with at the end of the working session, if possible.
- The patient should spend the minimum time in the department or waiting area, being sent for when the department is ready, if possible.
- Staff coming into close contact with the patient should wear disposable gloves and plastic aprons. The importance of hand hygiene should be emphasised.
- Equipment and the number of staff attending should be kept to a minimum.
- Surfaces the patient has had direct contact with should be cleaned.
- Linen should be treated according to local hospital or clinic policy.

8.3 General practice and other community-based services

These services include general practices, ambulance services and district nursing.

Carriage of MRSA is asymptomatic and therefore many carriers go undetected. This means that good infection control practices must be employed for all patients, *not* just those known to be colonised or infected with MRSA.

If a patient is known to be positive for MRSA it is important to notify these services. This will allow the service to ensure:

- hand hygiene is performed before and after dealing with the patient
- contact precautions are used, where appropriate
- linen is treated according to service policy – after use, gowns/aprons and sheets should be discarded into a soiled linen container for appropriate laundering.

No special or extra cleaning is needed after caring for or transporting the patient with MRSA. Routine cleaning practice is sufficient. Appropriate treatment choices can be made if there is MRSA infection.

8.4 Referral to hospital

When hospital admission is required, it is the responsibility of the patient's primary health care provider to alert the hospital of the patient's MRSA status. On discharge of the patient to the community, the discharging facility is responsible for providing community staff with an update of the patient's MRSA status and necessary treatment and clearance procedures.

9 National Surveillance of MRSA

National surveillance of MRSA is important to:

- characterise and determine the current prevalence and epidemiology of MRSA in New Zealand
- characterise the epidemic potential or transmissibility of specific strains of MRSA
- identify health care facilities with recent isolations of MRSA
- follow the spread of MRSA between health care facilities.

This information is useful in the clinical care of patients who become infected with MRSA, in the control of MRSA outbreaks within a health care facility, and for preventing the spread of MRSA from one health care facility to another.

National surveillance of MRSA is co-ordinated through the Nosocomial Infections Laboratory at the Institute of Environmental Science and Research (ESR). Currently, routine national surveillance is confined to multiresistant MRSA (mMRSA). All mMRSA isolates should be referred to ESR. Referred isolates are confirmed as oxacillin-resistant, phage typed, and tested for their susceptibility to other antibiotics. If phage typing is inconclusive in identifying the strain, or if further discrimination between isolates is required, DNA macro-restriction analysis using pulsed-field gel electrophoresis is used as a supplementary typing system.

MRSA Referral and Epidemiological Data Form (see Appendix 5) should be completed for each person from whom mMRSA is isolated, and should be submitted with the isolate. This form includes information on the date of isolation, hospitalisation history, overseas travel, and MRSA contact. This data, along with the results of tests done at ESR, is used to characterise mMRSA in New Zealand and to identify health care facilities with recent mMRSA isolations. Information on recent mMRSA isolations and those health care facilities that have had two or more patients or staff with mMRSA in the last three months is published on a weekly basis in the *MRSA Report*. ESR needs timely submission of mMRSA isolates, accompanied with complete and accurate information, to ensure the usefulness of the data published in the *MRSA Report*. The mMRSA isolates and accompanying Referral and Epidemiological Data Forms should be sent to:

Nosocomial Infections Laboratory
Communicable Disease Group
ESR
34 Kenepuru Drive
PO Box 50-348
Porirua.

The MRSA Report

The *MRSA Report* aims to present the most up-to-date information on which health care facilities currently have mMRSA isolations and, in particular, cross-infections. However, the information in the report is inevitably at least two to three weeks out of date. Also, due to some health care facilities withholding permission to publish their identity, the report does not include a complete list of facilities with mMRSA. Therefore, when patients are being transferred or staff employed, there should be good communication and exchange of information between facilities to ensure that the risk of MRSA transmission is minimised. The *MRSA Report* should be seen as complementary to this communication – not an alternative to it.

Each year, in addition to the routine and ongoing surveillance of mMRSA, a one-month survey of all MRSA (both multiresistant and non-multiresistant isolates) is undertaken to provide more complete information on the epidemiology of MRSA in New Zealand. For this survey, laboratories are requested to refer to ESR all MRSA isolated in their laboratory for a period of one month. The data collected on these isolates and the testing performed are similar to those for the routine surveillance of mMRSA.

Besides the publication of the weekly *MRSA Report*, six-monthly summaries of the epidemiology of mMRSA in New Zealand are published in the ESR publication *LabLink*. The results of the one-month survey are also published annually in *LabLink*.

10 Microbiology Procedures

10.1 Culture for MRSA

Detection of methicillin resistance in *S. aureus* requires standard techniques. Heteroresistance is commonly encountered, in which susceptible and resistant variants coexist. Therefore techniques for isolation and susceptibility testing need to be designed to favour the growth of resistant sub-populations. Conditions that allow this include neutral pH, cooler temperatures (30–35°C), the presence of NaCl (2–4%) and possibly prolonged incubation (up to 48 hours).

Laboratories should use a sensitive method when culturing for MRSA. Methods using selective media containing oxacillin (this is more likely to detect resistance than methicillin or nafcillin) with a broth enrichment stage are reported to be more sensitive than direct-plating methods alone (Gardam et al 2001). Screening swabs can be plated directly on to agar and then placed in an enrichment broth. Swabs from multiple body sites can be plated on to sectors of the same agar plate and then placed in the same enrichment broth.

The following methods are suggested for the direct plating and broth enrichment procedures.

Direct plating

- Plate swabs directly on to blood agar and media containing a breakpoint concentration of oxacillin or methicillin (for example, a nutrient agar, blood agar, mannitol salt agar containing 4 mg/L oxacillin, or oxacillin resistance agar containing 2 mg/L oxacillin and polymyxin B).
- Incubate at 30 or 35°C. Read plates at 18–24 and 42–48 hours (Davies and Zadik 1997).

Broth enrichment

- Place swabs in an enrichment broth such as salt broth (for example, Oxoid No. 2 nutrient broth with 7% added NaCl). Incubate at 35°C for 24 hours.
- Subculture broths on to the media used for direct plating. Local experience may allow for modification of this.
- Incubate at 30 or 35°C for 48 hours.
- Plates can be read at 24 and 48 hours.

The use of broth cultures has been shown to increase the yield of MRSA from screening swabs. The increased yield has been found to range from 13% to 23% more MRSA-positive patients per surveillance event than using solid media alone (Gardam et al 2001). Local studies have confirmed this observation (M Schousboe, personal communication, February 2002).

Any typical *S. aureus* colonies should be picked from the plates and have identification and methicillin susceptibility tests performed.

Individual strains of MRSA may vary in their growth characteristics on different media, or in their reactions in laboratory tests. For example, one phenotype of EMRSA-15 in New Zealand gives a delayed coagulase reaction in all but one method. Local isolation and susceptibility techniques should be aimed at detecting the MRSA strains currently circulating.

10.2 Oxacillin/methicillin susceptibility tests

Standard susceptibility tests may fail to detect methicillin resistance. Added salt in the culture medium, a direct rather than log-phase inoculum, a heavy inoculum, and incubation at 30 or 35°C for a full 24 hours all increase the sensitivity of the test. In addition, with disc diffusion tests, close examination of the zones of inhibition for faint growth and small colonies will help in the detection of highly heteroresistant strains. Heteroresistant strains are more likely to be detected using oxacillin screening plates. This is a Mueller-Hinton agar supplemented with 4% NaCl and containing 6 mg/L oxacillin. This plate should be inoculated using a cotton swab dipped into a direct colony suspension equivalent to a 0.5 McFarland standard. The plate is incubated at not more than 35°C for 24 hours and examined carefully with transmitted light for evidence of small colonies (> 1 colony) or a light film of growth indicating oxacillin resistance.

The National Committee for Control of Laboratory Standards (NCCLS) methods of oxacillin/methicillin susceptibility testing are recommended (National Committee for Control of Laboratory Standards 2000a; 2000b; 2002). These methods and their interpretation are summarised in the following table:

Table 1: NCCLS methods for determining the oxacillin/methicillin susceptibility of *Staphylococcus aureus*

Method	Medium/antibiotic	Inoculum	Incubation	Expected values for MRSA
Broth micro-dilution MIC test	2% NaCl supplemented Mueller-Hinton broth	5 x 10^5 CFU/ml by direct suspension	35°C for 24 hours	Methicillin MIC ≥ 16 mg/L; oxacillin MIC ≥ 4 mg/L
Oxacillin agar screen test	4% NaCl supplemented Mueller-Hinton agar with 6 mg/L oxacillin	1 x 10^8 CFU/ml by direct spot inoculation	35°C for 24 hours	Distinct growth spot on agar surface
Disc diffusion	Mueller-Hinton agar with 1 µg oxacillin or 5 µg methicillin disc	1 x 10^8 CFU/ml by swab inoculation of plate surface	35°C for 24 hours	Methicillin zone ≤ 9 mm; oxacillin zone ≤ 10 mm

While the NCCLS methods include the use of oxacillin or methicillin, oxacillin is recommended unless a particular MRSA strain is shown to be more readily detected with methicillin. The breakpoints given in the table are applicable only to the results of tests for which the NCCLS methodology has been strictly adhered to.

Laboratories using methods other than those of the NCCLS should validate their susceptibility test methods against the NCCLS methods. The Antibiotic Reference Laboratory, ESR, can provide strains of MRSA for such validation studies. This

laboratory can also provide advice on the relative sensitivity and specificity of various methods.

E-test (AB Biodisk, Solna Sweden) is useful for determining the oxacillin MIC using Mueller-Hinton plates containing 2% NaCl inoculated with a direct colony suspension equivalent to a 0.5 MacFarland standard. The plates are incubated at 35°C for 24 hours.

Automated susceptibility systems that detect methicillin resistance include:

- Microscan conventional panels (Pos Combo 10 panels; Dade Behring Inc./ Microscan Inc., West Sacramento, California)
- Microscan rapid panels (Rapid POS MIC 1)
- Vitek (GPS-107; bioMerieux, Inc., Hazelwood, Missouri).

10.3 Other methods for detecting methicillin resistance

Other methods have been described for detecting methicillin resistance. These include:

- detection of the *mecA* gene (Velogene Alexon-Trend Inc., Ramsay, Minnesota)
- detection of PBP2a (MRSA Screen Denka Seiken Co. Ltd, Tokyo, Japan).

Using a set of challenge organisms, the following sensitivities/specificities (%) have been reported Swenson et al 2001:

- Velogene 100/100
- MRSA screen 100/100 when agglutination read at 15 minutes.

Reference testing for *mecA* is available at ESR. However, methods that detect *mecA* are unable to determine whether the gene is being expressed. This type of method will also miss methicillin resistance from other causes, such as other modification of penicillin-binding proteins.

If these tests are used it is important to evaluate them in the local setting.

Note: No routine test for MRSA is 100% sensitive and specific.

10.4 Borderline-resistant *S. aureus* (BORSA)

Some strains of *S. aureus* produce such large amounts of penicillinase that the penicillinase-resistant penicillins are gradually hydrolysed. These strains may show reduced or borderline susceptibility to oxacillin or methicillin in susceptibility tests, and they are referred to as BORSA. BORSA may be detected with an amoxicillin-clavulanate disc, or by adding clavulanic acid or another beta-lactamase inhibitor to the MIC or agar screen media. They will test as susceptible under these conditions (Liu et al 1990).

10.5 Mupirocin susceptibility testing

Mupirocin is a topical antibiotic which is used to clear staphylococcal carriage. Current recommended breakpoints are ≤ 4 mg/L susceptible and ≥ 8 mg/L resistant (Finlay et al 1997). Disc testing can be performed using a 5 μg disc. Zone diameters are ≥ 14 mm susceptible and ≤ 13 mm resistant. The E-test has been found reliable for MIC determination.

Two levels of resistance are described currently: 8–256 mg/L as low-level resistance and ≥ 512 mg/L as high-level resistance.

10.6 Testing for multiresistant MRSA

It is recommended that all MRSA be routinely tested for susceptibility to co-trimoxazole erythromycin, fusidic acid, mupirocin, and tetracycline or doxycycline. Testing susceptibility to ciprofloxacin, clindamycin, gentamicin, rifampicin and vancomycin should be performed routinely in the hospital setting, but need only be done on request in the community setting. The antibiotics tested will be up to the individual laboratory to decide on, in conjunction with the clinical microbiologist.

EMRSA-15 is usually resistant to ciprofloxacin and erythromycin, in addition to methicillin/oxacillin. However, about 15% of EMRSA-15 currently being isolated in New Zealand are erythromycin susceptible. Therefore, if ciprofloxacin/fluoroquinolone susceptibility is not tested, these erythromycin-susceptible EMRSA-15 isolates will appear to be resistant to β-lactams alone. On the basis of susceptibility pattern, they will be indistinguishable from the common, community, non-multiresistant WSPP MRSA. It is strongly recommended, at least in areas where EMRSA-15 is being isolated, that ciprofloxacin/fluoroquinolone susceptibility be routinely tested.

10.7 Vancomycin susceptibility testing

If reduced susceptibility to glycopeptides is suspected – either because of an apparent treatment failure or from the results of initial routine susceptibility tests – further testing should be performed using methods that have been shown to be sensitive and specific for the detection of VISA and heteroresistant (hVISA). In general, VISA and (hVISA) cannot be reliably distinguished from vancomycin-susceptible strains by the rapid automated susceptibility testing methods or by disc testing. It should be noted that cultures of VISA – and especially heteroresistant (hVISA) – often appear mixed as they typically display heterogeneous colonial morphology. However, both colony types yield identical antimicrobial susceptibility patterns.

10.7.1 VISA

A single MIC method may not be adequate to detect all VISA strains. Experience overseas suggests that the following three criteria need to be met:

- broth microdilution vancomycin MIC of 8–16 mg/L
- E-test vancomycin MIC ≥ 6 mg/L
- growth on commercial brain–heart infusion (BHI) agar screen plates containing 6 mg/L of vancomycin within 24 hours (Tenover et al 2001).

10.7.2 Heteroresistant VISA

In standard susceptibility tests hVISA usually appears susceptible, with MICs in the range of 1–4 mg/L, but these strains have a sub-population of cells with intermediate resistance. This sub-population may be as few as 1 in 10^6 cells.

Current experience indicates that hVISA is most reliably detected with vancomycin and teicoplanin E-tests using a heavy inoculum (to enhance detection of the resistant sub-population) and BHI agar as the test medium (Walsh et al 2001).

From a fresh overnight culture, prepare a broth suspension adjusted to a turbidity equivalent to 2.0 McFarland standard (approximately 6 x 10^8 cfu/mL). Spread 200 µL of the adjusted broth suspension over the surface of a brain–heart infusion agar plate. Allow the plate to dry for 10 minutes, then apply the vancomycin and teicoplanin E-test strips. Incubate at 35°C and read the MICs at both 24 and 48 hours. Examine zones carefully for single colonies and microcolonies. Isolates with vancomycin and teicoplanin MICs of ≥ 8 mg/L or a teicoplanin MIC ≥ 12 mg/L should be considered possible VISA or hVISA.

Note: The Infection Control Team should be notified immediately of the isolation of any suspected VISA or hVISA.

All possible VISA and hVISA, whether clinically or microbiologically suspected, should be referred to ESR for confirmation. In addition, any laboratories not having the materials to perform the tests described above should refer any suspect isolates directly to ESR.

Glossary

Carbapenems Bicyclic ß-lactam antibiotics. Carbapenems exhibit the broadest antimicrobial spectrum of any group of ß-lactam antibiotics available to date. The agents available in this class in New Zealand are imipenem, ertapenem and meropenem. MRSA are resistant to carbapenems.

Carriage The harbouring of MRSA with no overt expression of clinical disease. Individuals carrying MRSA are a potential source for the spread of the organism. Recognised sites of carriage for MRSA include the nose, throat and certain skin sites, such as perineum, groin, axilla and buttock. Carriage can be transient, intermittent or of long duration (chronic).

Cephalosporins ß-lactam antibiotics. Cephalosporins have a six-membered ring fused to the ß-lactam ring, as opposed to penicillins, which have a five-membered ring. They have a broad spectrum of activity against both gram-negative and gram-positive bacteria. Simplistically, they are classified as first, second, third and possibly fourth generation cephalosporins based on activity against bacteria and enhanced ß-lactamase stability. MRSA is resistant to all cephalosporins.

Cohorting of nursing staff A procedure whereby one group of nursing staff within a unit or ward provide nursing care for all the patients with MRSA for the duration of the isolation.

Cohorting of patients Grouping of patients with MRSA separately from patients without MRSA. Patients may be placed in single rooms within one area, in a multi-bedded room or in a small ward. In certain settings where it may not be possible to have patients with MRSA separated from those without MRSA (for example, intensive care units), then physical separation within the room should occur.

Colonisation The presence of an organism in or on a host that does not cause a specific immune response or infection.

Contact precautions Precautions used for patients known or suspected to be infected or colonised with epidemiologically important micro-organisms that are transmitted by direct contact with the patient (hand or skin-to-skin contact that occurs when performing patient-care activities that require touching the patient's dry skin), or indirect contact with environmental surfaces or patient care items in the patient's environment (Hospital Infection Control Practices Advisory Committee 1996; see Appendix 6).

Droplet precautions	Transmission-based precautions intended to reduce droplet transmission of infectious pathogens. Droplet transmission occurs when large-particle droplets (> 5 μm in diameter) from an infectious person make contact with the mucous membranes of the nose, mouth or conjunctivae of another person (Hospital Infection Control Practices Advisory Committee 1996; see Appendix 6).
EMRSA	A term used in the United Kingdom to describe MRSA strains that are known to spread easily between and within health care facilities and cause epidemics (for example, EMRSA-15).
Endemic MRSA	The continuing presence of MRSA, with or without infection, in a given health care facility, or in a specific group of patients in the hospital, despite standard control procedures.
E-test	An in-vitro method for quantitative antimicrobial susceptibility testing, whereby a pre-formed antimicrobial gradient from a plastic-coated strip diffuses into the agar medium inoculated with the test organism. The test allows the determination of the MIC of the antibiotic against the tested organism.
GISA	Glycopeptide-intermediate *Staphylococcus aureus*.
Glycopeptides	A class of antibiotics that inhibit cell wall synthesis. They are active only against gram-positive organisms. Vancomycin and teicoplanin are the only glycopeptides available for use in humans in New Zealand.
Hand hygiene	A general term that applies to either handwashing, antiseptic handwash, antiseptic handrub/gel or surgical hand antisepsis.
Hand washing	Washing hands with plain (non-antimicrobial) soap and water.
Health care facility	Any facility from which the health and/or disability service is provided; this includes acute care, ambulatory and long-term care facilities (see also RCF).
Health care worker	Any individual who works within a health care facility providing clinical care to the patients or residents of that facility.
Heteroresistance	Variable resistance within a bacterial population to an antibiotic. Detecting this type of resistance in the laboratory can be difficult.
Index case	The first case in an outbreak of MRSA.
Infection Control Team (ICT)	An individual/group of health professionals competent in infection control who have the responsibility for implementing the infection control programme. Team members will be qualified health professionals with access to a network of appropriately qualified infection control practitioners/specialists.

MIC	Minimum inhibitory concentration, the lowest concentration of an antimicrobial agent that will inhibit the growth of a test organism over a defined interval related to the organism's growth rate, most commonly 18–24 hours.
mMRSA	Multiresistant MRSA (see below).
Monobactams	ß-lactam antibiotics. The ß-lactam ring is not fused to another ring. These agents exhibit no activity against gram-positive organisms or strict anaerobes. They are active against a wide range of aerobic gram-negative organisms. Aztreonam is the most widely available monobactam in New Zealand.
MRSA	Methicillin-resistant *Staphylococcus aureus.*
MSSA	Methicillin-susceptible *Staphylococcus aureus.*
Multiresistant MRSA (mMRSA)	MRSA isolates that are resistant to two classes of antibiotics other than ß-lactam antibiotics.
Mupirocin	A topical antimicrobial agent with activity against most gram-positive organisms and certain gram-negative organisms, but not *Pseudomonas aeruginosa*. Its mechanism of action is by the inhibition of protein synthesis. Its greatest value is in the eradication of nasal carriage of MRSA.
Pacific peoples	The population of Pacific Islands ethnic origin (including Tongan, Niuean, Fijian, Samoan, Cook Islands Māori, Tokelauan), incorporating peoples of Pacific Islands ethnic origin born in New Zealand as well as overseas.
PCR	Polymerase chain reaction, a method for nucleic acid amplification.
Phage pattern	The pattern of susceptibility of *Staphylococcus aureus* to a standard set of lytic bacteriophages (viruses that infect and lyse bacterial cells). Differences in phage patterns are used to distinguish between strains of *S. aureus*.
Residential care facilities (RCFs)	This term includes rest homes, private hospitals providing non-acute care, hospices, rehabilitation inpatient facilities and other residential facilities not providing acute care.
Standard Precautions	Precautions used for all patients regardless of their known infection state, which apply to blood and all body fluids, including secretions and excretions (except sweat), whether or not they contain visible blood (Hospital Infection Control Practices Advisory Committee 1996; see Appendix 6).

Transmission-based isolation precautions	Precautions used for patients known or suspected to be infected or colonised with epidemiologically important pathogens that can be transmitted by airborne, droplet or contact transmission. These precautions may be combined for diseases that have multiple routes of transmission. When used either singly or in combination, these precautions are to be used along with the Standard Precautions.
Universal Precautions	The concept of universal blood and body fluid precautions was first introduced in 1985 by the Centers for Disease Control, Atlanta, Georgia. These precautions emphasised applying blood and body fluid precautions universally to all persons irrespective of their presumed infection status. The precautions were primarily designed to prevent occupational infection in health care workers, as opposed to being tailored to reduce the risk of spread of pathogens from patient to patient or from health care worker to patient. In 1996 Universal Precautions were replaced by Standard Precautions. Standard Precautions combine the major features of Universal Precautions and Body Substance Isolation.
Vancomycin	A glycopeptide antibiotic. It is the most commonly used antibiotic for serious MRSA infection.
VISA	Vancomycin-intermediate *Staphylococcus aureus.*
VRSA	Vancomycin-resistant *Staphylococcus aureus.*
WSPP MRSA	Western Samoan phage-pattern methicillin-resistant *Staphylococcus aureus*. Two strains with different phage patterns, WSPP1 and WSPP2, are recognised. These MRSA are usually susceptible to other classes of antibiotics.

Appendices

Appendix 1: Letter to General Practitioner and/or District Nurse

Date: _____

Dr/Nurse _____

_____

_____

Re:_____ (patient's name)

_____ (NHI)

The above patient under your care has been found to be colonised/infected with methicillin-resistant *Staphylococcus aureus* (MRSA). MRSA are strains of *S. aureus* which are resistant to the semi-synthetic penicillins (for example, methicillin, oxacillin, flucloxacillin) and may be resistant to other antibiotics (for example, erythromycin, chloramphenicol, gentamicin, cotrimoxazole, tetracycline). As a whole, MRSA strains do not behave differently from methicillin-sensitive strains with respect to spread, virulence or survival. However, they are of concern due to the limited options available for the treatment of serious infections.

MRSA has been isolated from your patient at the following site(s):

_____

_____

This MRSA strain is resistant to:

_____

This MRSA strain is susceptible to:

_____

The following treatment has been initiated/completed during hospitalisation:

_____

_____

_____

Clearance swabs have/have not been collected from the patient and s/he is considered/no longer considered to be colonised/infected.

We would be grateful if you could arrange the following (treatment and/or screening swabs which are needed after discharge):

_____

_____

[If the patient has not been cleared of MRSA, include the following paragraphs.]

If the patient visits your surgery or clinic, arrangements should be made so that s/he spends a minimum amount of time in the waiting room. Appropriate infection control procedures should be maintained by all health care staff in direct contact with the patient. **Effective hand hygiene is the most effective procedure in controlling the spread of infection**. This can be accomplished by handwashing or the use of alcohol-based hand rubs/gels. Protective clothing should be worn if in direct contact with the patient. Gloves should be worn if contaminated dressings or linens are handled. Any equipment or surfaces the patient has had direct contact with should be cleaned thoroughly. Linen, contaminated equipment and rubbish should be disposed of according to local policy.

A change in the patient's health status (for example, treatment with antibiotics, development of lesions) may lead to the re-emergence of MRSA in patients previously cleared. It is important to remain aware of the potential carriage of MRSA by this patient in the future.

Should there be any questions about MRSA or the follow up of this patient, please contact the infection control nurse/infection control doctor/medical microbiologist at _____ Hospital (telephone number: _____).

It would be helpful for those seeing the patient in the future if any referral letter mentioned that the patient has had MRSA in the past.

Yours sincerely

_____

Appendix 2: Letter to the Infection Control Team at a Receiving Health Care Facility

Date: _____

The Infection Control Doctor _____

_____

_____

Dear Colleague

The following patient, _____ , (NHI _____) has [choose one]:

* been found to be a carrier of methicillin-resistant *Staphylococcus aureus* (MRSA) at the following sites:_____
* has been nursed in a ward with other patients infected with MRSA.

This MRSA strain is resistant to:

_____

This MRSA strain is susceptible to:

_____

I understand that s/he is to be transferred to your hospital/hospice/convalescent home. If you would like further details regarding culture results or treatment to date, please contact the infection control nurse / infection control doctor/medical microbiologist at _____ Hospital (telephone number: _____).

Yours sincerely

_____

Appendix 3: Methicillin-resistant *Staphylococcus aureus* (MRSA): Information for patients and their family/whānau

What's MRSA?

MRSA stands for Methicillin-resistant *Staphylococcus aureus.*

Staphylococcus aureus (*S. aureus*) is a bacterium or germ that normally lives on the skin and usually causes no harm. It can also be found in the warm, moist environment of the nose and groin.

This bacterium has developed a resistance to a group of commonly used antibiotics such as methicillin. This group of antibiotics also includes other penicillin-like drugs.

MRSA may be present on the skin for a long time without causing any harm. If it gets into a wound or break in the skin, it can cause an infection.

When a person has an infection caused by MRSA it can be difficult to treat. An antibiotic that is not routinely used will be required to treat the infection.

How did you know that I have MRSA?

- You may have had MRSA in the past.
- You may have had a positive wound swab.

Special precautions now need to be taken and you will need to be isolated.

What does colonisation mean?

Further swabs may need to be taken from your nose and perineum (between your legs) and any other wound area.

The results of these swabs will determine whether you are colonised or not. We say a person is colonised with MRSA when it is found on the skin and/or in the nose. These body areas may need to be treated appropriately to prevent further infection.

If MRSA is found on your skin, you may be asked to wash with a special disinfectant soap. If MRSA is found in your nose, a special ointment may need to be placed in the nostrils. You may also be placed on different antibiotics if MRSA is found in your wound.

What does isolation mean?

If you are placed in isolation, it means that people caring for you may have to take special precautions.

The isolation precautions are as follows.

- You may be placed in a single room to minimise contact with other patients.
- Gloves may be worn by staff coming in contact with you to prevent the MRSA from being transferred onto their hands.
- Gowns sometimes may be worn by staff to stop MRSA getting on to their clothing. Sometimes masks may need to be worn by those having direct contact with you. You may need to wear a mask if leaving the room for some reason.
- **Everybody leaving the room must wash their hands or use the alcohol hand rub/gel provided.**

How long do I have to stay in isolation?

This will vary from person to person. If you are on antibiotics we need to wait until after the antibiotics have finished. Three separate swabs will then be taken at least 24 hours apart. The result of these may take three days.

All three need to return with a negative result before isolation can be stopped.

You may be sent home before this stage is reached.

When the MRSA has gone, is there a chance it will return?

Unfortunately, once MRSA has been present on your body it may come back, even if swabs have been negative after treatment.

So ....

whenever you are admitted to a hospital you will need to be re-swabbed to check for MRSA. The result of these swabs may affect whether you are placed in a room with other patients.

Is MRSA dangerous to my family/whänau?

No. MRSA is only a problem for patients when they are sick in hospital. If a family/ whānau member or visitor picks up the bacteria it will cause them no harm.

MRSA is not a bacteria that floats in the air. It is spread by touching. It is important that visitors wash their hands before leaving the room and after assisting with any of your direct care.

If your visitors are seeing other people in the hospital ask them to visit them first before visiting you.

Going home

Good hygiene is sufficient.

The very best way to prevent the spread of germs is by frequent good handwashing.

Appendix 4: Screening for methicillin-resistant *Staphylococcus aureus* (MRSA): Patient information

What is MRSA?

MRSA stands for methicillin-resistant *Staphylococcus aureus.*

Staphylococcus aureus (*S. aureus*) is a bacterium or germ that normally lives on the skin and usually causes no harm. It can also be found in the warm, moist environment of the nose and groin.

This bacterium has developed a resistance to a group of commonly used antibiotics such as methicillin. This group of antibiotics also includes other penicillin-like drugs.

MRSA may be present on the skin for a long time without causing any harm. If it gets into a wound or break in the skin, it can cause an infection.

When a person has an infection caused by MRSA it can be difficult to treat. An antibiotic that is not routinely used will be required to treat the infection.

Why do I need to be screened for MRSA?

- You may have had MRSA in the past.
- You may have been in another hospital recently.

Many hospitals overseas (and most in this country) have outbreaks of MRSA. Patients who have been in these hospitals may have MRSA living on their skin. We cannot tell by simply looking who has MRSA. All patients from these hospitals are treated with special precautions and are isolated until they are shown not to have MRSA.

How will they find out if I have MRSA?

- If the swabs do grow MRSA, you will have to stay in isolation.
- If the swabs do not grow MRSA, you will be taken out of isolation.

Swabs are taken from your nose and perineum (between your legs) and any wounds you might have. These are sent to the laboratory for culture. It takes at least three days to get a complete result from your swab.

What does isolation mean?

If you are placed in isolation, it means that people caring for you may have to take special precautions. The isolation precautions are as follows.

- You may be placed in a single room to minimise contact with other patients.
- Staff coming in contact with you may wear gloves to prevent the MRSA from being transferred onto their hands.
- Staff may sometimes wear gowns to stop MRSA getting on to their clothing.
- Sometimes masks may need to be worn by those having direct contact with you. You may need to wear a mask if you leave the room for some reason.
- **Everybody leaving the room must wash their hands or use the alcohol hand rub/gel provided.**

Why do I need to be in isolation?

MRSA is still uncommon in New Zealand hospitals. If MRSA causes an infection it can be more difficult to treat and requires the use of reserved antibiotics. Therefore, it is important to prevent its spread to staff and other patients. Isolation achieves this.

Appendix 5: MRSA Referral and Epidemiological Data Form

So that we can compile comprehensive data on MRSA in New Zealand, and correctly report your isolate in the weekly MRSA Report, please supply the details requested below about the MRSA isolate you are referring. **Forward this form with the isolate to the Nosocomial Infections Laboratory, ESR Kenepuru Science Centre, PO Box 50-348, Porirua.**

1 **Complete this section for all MRSA isolates**

Place laboratory name stamp here

Lab No:..... Hospital No: .....

Surname:..... First Name: .....

DOB/age:..... Sex:..... Ethnicity: ..... Doctor:.....

Patient's Health District: ..... Date specimen collected:.....

Any contact with persons known to have MRSA: .....

Any overseas travel in last 12 months:.....

Is the isolate multiresistant to at least two antibiotics in addition to methicillin/oxacillin and other β-lactams?

Yes ☐ No ☐

If yes, please specify the antibiotics: .....

Specify any tests required other than phage-typing and confirmation of oxacillin resistance: .....

Site of isolation: *(please tick appropriate box(es))*

Site(s)	Wound	Abscess	Boil	Skin lesion	Burn	Nose	Groin/ perineum	Other (specify): ....
Infected								
Colonised								
Not known								

Was the MRSA isolated from: MRSA screen ☐ Admission swab ☐ Other ☐

2 Complete this section if MRSA was isolated from a patient

2.1 Did the patient have any hospital or long-term care facility (RCF) contact at the time the MRSA was isolated?

Yes ☐ No ☐

If yes: hospital/RCF and ward/department/clinic: .....

Status:
In hospital/RCF ☐ In isolation from time of admission ☐ Outpatient clinic ☐ Emergency ☐

2.2 Has the patient had any previous hospital/RCF contact?

Yes ☐ No ☐

If yes: hospital/RCF(s) and discharge date(s): .....
.....

Any other details: .....
.....

3 Complete this section if MRSA was isolated from a health care worker

3.1 Was the MRSA isolated from a pre-employment screen?

Yes ☐ No ☐

3.2 Did the health care worker have direct patient contact at the time the MRSA was isolated?

Yes ☐ No ☐

If yes: hospital/RCF and ward/department/clinic: .....
.....

Any other details: .....
.....

3.3 Work history in last 12 months (further to any specified in 3.2): .....

Specify hospital/RCF(s), service(s) and dates: .....

Appendix 6: Standard, Contact and Droplet Precautions

Standard precautions shall be used for all patient contact.

In the context of these MRSA guidelines, contact precautions are additional precautions used for known or suspected MRSA patients. Droplet precautions are used on those occasions when droplets are created during care of MRSA positive patients. Masking may also be appropriate in other circumstances (see sections 4.3.2 and 4.3.3).

The following information is reproduced from the Guideline for Isolation Precautions in Hospitals, produced by the USA Centers for Disease Control and Prevention and the Hospital Infection Control Practices Advisory Committee (Hospital Infection Control Practices Advisory Committee 1996). See www.cdc.gov/ncidod/hip/isolat/isolat.htm.

1 Standard precautions

Use standard precautions for the care of all patients.

A Handwashing

1 Wash hands after touching blood, body fluids, secretions, excretions, and contaminated items, whether or not gloves are worn. Wash hands immediately after gloves are removed, between patient contacts, and when otherwise indicated to avoid transfer of micro-organisms to other patients or environments. It may be necessary to wash hands between tasks and procedures on the same patient to prevent cross-contamination of different body sites.

2 Use a plain (non-antimicrobial) soap for routine handwashing.

3 Use an antimicrobial agent or a waterless antiseptic agent for specific circumstances (eg, control of outbreaks or hyperendemic infections), as defined by the infection control programme. (See contact precautions for additional recommendations on using antimicrobial and antiseptic agents.)

B Gloves

Wear gloves (clean, non-sterile gloves are adequate) when touching blood, body fluids, secretions, excretions, and contaminated items. Put on clean gloves just before touching mucous membranes and non-intact skin. Change gloves between tasks and procedures on the same patient after contact with material that may contain a high concentration of micro-organisms. Remove gloves promptly after use, before touching non-contaminated items and environmental surfaces, and before going to another patient, and wash hands immediately to avoid transfer of micro-organisms to other patients or environments.

C Mask, eye protection, face shield

Wear a mask and eye protection or a face shield to protect mucous membranes of the eyes, nose, and mouth during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions and excretions.

D Gown

Wear a gown (a clean, non-sterile gown is adequate) to protect skin and to prevent soiling of clothing during procedures and patient-care activities that are likely to generate splashes or sprays of blood, body fluids, secretions, or excretions. Select a gown that is appropriate for the activity and amount of fluid likely to be encountered. Remove a soiled gown as promptly as possible, and wash hands to avoid transfer of micro-organisms to other patients or environments.

E Patient-care equipment

Handle used patient-care equipment soiled with blood, body fluids, secretions, and excretions in a manner that prevents skin and mucous membrane exposures, contamination of clothing, and transfer of micro-organisms to other patients and environments. Ensure that reusable equipment is not used for the care of another patient until it has been cleaned and reprocessed appropriately. Ensure that single-use items are discarded properly.

F Environmental control

Ensure that the hospital has adequate procedures for the routine care, cleaning, and disinfection of environmental surfaces, beds, bed rails, bedside equipment, and other frequently touched surfaces and ensure that these procedures are being followed.

G Linen

Handle, transport and process used linen soiled with blood, body fluids, secretions, and excretions in a manner that prevents skin and mucous membrane exposures and contamination of clothing, and that avoids transfer of micro-organisms to other patients and environments.

H Occupational health and bloodborne pathogens

1 Take care to prevent injuries:

- when using needles, scalpels and other sharp instruments or devices;
- when handling sharp instruments after procedures;
- when cleaning used instruments; and
- when disposing of used needles.

Never recap used needles, or otherwise manipulate them using both hands, or use any other technique that involves directing the point of a needle toward any part of the body; rather, use either a one-handed 'scoop' technique or a mechanical device designed for holding the needle sheath. Do not remove used needles from disposable syringes by hand, and do not bend, break, or otherwise manipulate used needles by hand. Place used disposable syringes and needles, scalpel blades, and other sharp

items in appropriate puncture-resistant containers, which are located as close as practical to the area in which the items were used, and place reusable syringes and needles in a puncture-resistant container for transport to the reprocessing area.

2 Use mouthpieces, resuscitation bags, or other ventilation devices as an alternative to mouth-to-mouth resuscitation methods in areas where the need for resuscitation is predictable.

I Patient placement

Place a patient who contaminates the environment or who does not (or cannot be expected to) assist in maintaining appropriate hygiene or environmental control in a private room. If a private room is not available, consult with infection control professionals regarding patient placement or other alternatives.

2 Droplet precautions

In addition to standard precautions, use droplet precautions, or the equivalent, for a patient known or suspected to be infected with micro-organisms transmitted by droplets (large-particle droplets, larger than 5 µm in size, that can be generated by the patient during coughing, sneezing, talking, or the performance of procedures).

A Patient placement

Place the patient in a private room. When a private room is not available, place the patient in a room with a patient(s) who has active infection with the same micro-organism but with no other infection (cohorting). When a private room is not available and cohorting is not achievable, maintain spatial separation of at least one metre between the infected patient and other patients and visitors. Special air handling and ventilation are not necessary, and the door may remain open.

B Mask

In addition to standard precautions, wear a mask when working within one metre of the patient. (Logistically, some hospitals may want to implement the wearing of a mask to enter the room.)

C Patient transport

Limit the movement and transport of the patient from the room to essential purposes only. If transport or movement is necessary, minimise patient dispersal of droplets by masking the patient, if possible.

3 Contact precautions

In addition to standard precautions, use contact precautions, or the equivalent, for specified patients known or suspected to be infected or colonised with epidemiologically important micro-organisms that can be transmitted by direct contact with the patient (hand or skin-to-skin contact that occurs when performing patient-care activities that require touching the patient's dry skin) or indirect contact (touching) with environmental surfaces or patient-care items in the patient's environment.

A Patient placement

Place the patient in a private room. When a private room is not available, place the patient in a room with a patient(s) who has active infection with the same micro-organism but with no other infection (cohorting). When a private room is not available and cohorting is not achievable, consider the epidemiology of the micro-organism and the patient population when determining patient placement. Consultation with infection control professionals is advised before patient placement.

B Gloves and handwashing

In addition to wearing gloves as outlined under standard precautions, wear gloves (clean, non-sterile gloves are adequate) when entering the room. During the course of providing care for a patient, change gloves after having contact with infective material that may contain high concentrations of micro-organisms (faecal material and wound drainage). Remove gloves before leaving the patient's environment and wash hands immediately with an antimicrobial agent or a waterless antiseptic agent. After glove removal and handwashing, ensure that hands do not touch potentially contaminated environmental surfaces or items in the patient's room to avoid transfer of micro-organisms to other patients or environments.

C Gown

In addition to wearing a gown, as outlined under standard precautions, wear a gown (a clean, non-sterile gown is adequate) when entering the room if you anticipate that your clothing will have substantial contact with the patient, environmental surfaces, or items in the patient's room, or if the patient is incontinent or has diarrhoea, an ileostomy, a colostomy, or wound drainage not contained by a dressing. Remove the gown before leaving the patient's environment. After gown removal, ensure that clothing does not contact potentially contaminated environmental surfaces to avoid transfer of micro-organisms to other patients or environments.

D Patient transport

Limit the movement and transport of the patient from the room to essential purposes only. If the patient is transported out of the room, ensure that precautions are maintained to minimise the risk of transmission of micro-organisms to other patients and contamination of environmental surfaces or equipment.

E Patient-care equipment

When possible, dedicate the use of non-critical patient-care equipment to a single patient (or cohort of patients infected or colonised with the pathogen requiring precautions) to avoid sharing between patients. If use of common equipment or items is unavoidable, then adequately clean and disinfect them before use for another patient.

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